May 30, 1911.

POWER

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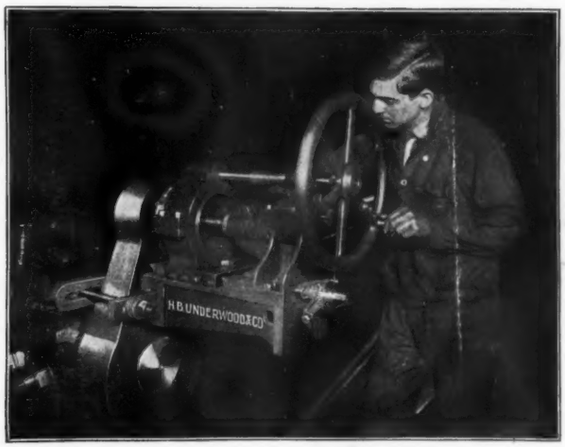
Engines Repaired Everywhere



Truing up a Crank Pin in Position.

Your engine and other breakdown jobs are bound to cost money, but the amount of money can be regulated by the promptness and accuracy with which repairs are made.

We know that delays and shutdowns are costly. We are, therefore, ready at a moment's notice (by letter, telegraph, or telephone) to send expert mechanics and special portable tools to make repairs IN POSITION to Engines, Ice Machines, and Pumps.

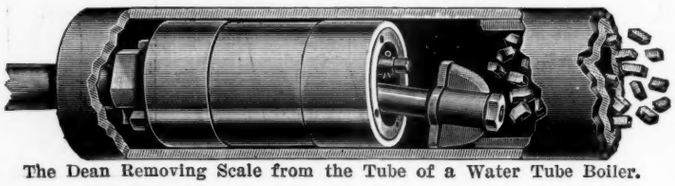
We appreciate the value of a good engine or pump and we realize that good repair work should restore original efficiency. We therefore, do first-class, accurate work and GUARANTEE it.

Our facilities take in the widest range of engine work. Cylinders from 3″ to 110″ diameter rebored. Any size Corliss valve seat rebored. Crank Pins from 20″ diameter down trued up. Valve seats in solid steam chests of any size refaced. And so on down the list. All work done in position and with our special machines.

All tools boxed and ready for shipment at a moment's notice. Send for our Bulletin. It will give you an idea of the kind of work we can do. And keep our name handy so that you can call on us when the inevitable breakdown occurs.

H. B. Underwood & Company

1021 Hamilton Street **Philadelphia, Pa.**



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Where To Look For Scale In A Fire Tube Boiler

You know that it is absolutely impossible to judge what condition the center tubes of a Fire Tube Boiler are in, don't you?

You can't see them, you can't get at them to clean them.

They may be heavily coated with scale for all you know.

The fact that the exposed tubes are clean is no indication of the condition of the center ones.

The outer tubes get the full force of the water in the wash-outs and they can be cleaned.

They are bound to be quite free of scale, if not entirely so.

The tubes that you will find dirty are the center ones—and that's where

The Dean Boiler Tube Cleaner

makes its showing.

It goes where no inspector can; it finds scale that can be found in no other way.

It operates on a principle that compels thoroughness—vibration—and if there is any scale anywhere it's got to fall.

Lots of engineers never knew they had scale until the DEAN showed up the true condition of their tubes.

Don't say *you* have no scale, until you have tried the Dean and found out for sure.

Not long ago a concern tried the Dean, although nobody around the plant believed there was any scale in the boilers Here's what the treasurer of the company wrote us immediately after the test: *"You win. Today we took 825 pounds of scale from a boiler we thought was clean. Please send bill."*

Who knows but what the Dean will be just as valuable to you?

Why not try a Dean? We'll loan it to you, free of charge, for a thorough trial in one boiler.

Write for it today before scale gets in some more of its injurious work.

The
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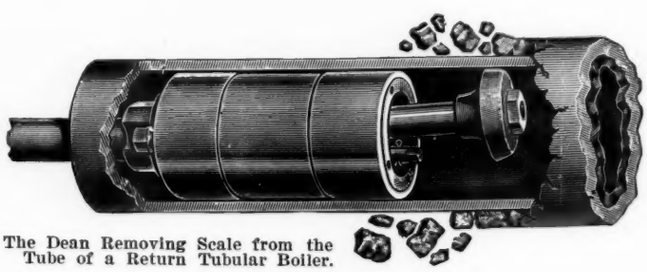


The Dean Removing Scale from the Tube of a Return Tubular Boiler.

POWER

NEW YORK, MAY 30, 1911

SOME years ago, so the story goes, a certain uptodate storekeeper hired two boys and set them to work undoing rolls of cloth in a rear room.

One of the boys was thrifty by nature and training; so was the other, but in a different way.

The first boy untied the cords that were around the rolls of goods he was working on, and carefully and painstakingly wound them up in a ball to save for future use. The wrapping paper was precisely folded and also tenderly lain aside.

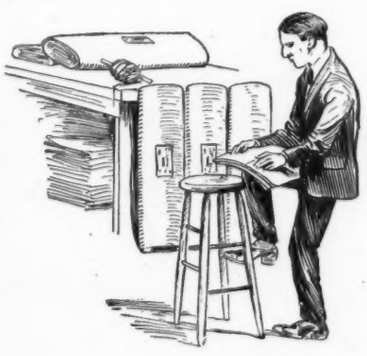
That boy was saving the cost of the cord and wrapping paper for his employer.

When the second boy began undoing his bundles, he got out his pocket knife, slashed the cord with one deft stroke and while placing the unwrapped goods in a pile with one hand gave the wrapping paper a fling that sent it on the floor behind him.

That boy was saving the cost of the cord and wrapping paper also, and then some.

Careful, painstaking methods of doing work are all right in their place, but the first boy, although saving the cord and paper, cost his employer more than it was worth in so doing. His output of useful work was reduced just the amount that could have been accomplished while wasting his time saving strings and brown paper.

The other boy expended his energies in useful work and left the paper and cord for the janitor to look after.



Now what does all this amount to to the engineer?

The same principle will apply to his work.

There is no saving in spending time picking coal out of the ash pile while air leaks are allowed to exist in the boiler setting.

The first boy might do it, but the boy with the knife would get after the leaks and let the ash handler look after the ash pile.

It is a waste of time to spend energy in stopping up a pin-hole leak in a steam pipe and allow the valves of the engine to be so set that the machine would run backward if given half a chance.

Fussing with the ash pile and the pin-hole leak will make a show toward economy, but attending to the real point of saving is what counts.

Can you imagine a ditch digger carefully selecting the exact spot where he intended to deposit each shovelful of earth?

But there is just as much sense in such a procedure as for the fireman to carefully spread green fuel over the fire and then leave the furnace doors open.

One procedure is a waste of time, the other a waste of money; both amount to the same in the end.

There are several methods of producing economy in a steam plant, as elsewhere. It is better to do things that produce results than to save paper and string.

A Remodeled Street Railway Plant

By Warren O. Rogers

This power plant contains the largest horizontal seven-stage Curtis turbine that has been put into service and also four of the largest Edge Moor boilers in New England. The station has been remodeled and provision made for future expansion.

One of the difficulties which the designing engineer encounters is that of looking ahead and providing for future growth and demands upon the steam plant. Frequently a power plant will be designed with such a capacity that, seemingly, it will be sufficient to meet all demands made upon it for years to come, when in reality two or three years finds the plant overloaded and incapable of economically carrying the load.

That is what occurred at the plant of the Worcester Consolidated Street Railway Company, which has recently been remodeled to meet the greater demands placed upon it. It is now constructed in such a manner that from the present plans its capacity can be increased threefold.

Prime Movers

The new power plant, shown in Fig. 1, is situated on Providence street, Millbury, Mass., a few miles out of Worcester. It contains two 300-horsepower reciprocating engines, direct coupled to generators; these two units comprised the original power plant. There is also one 5500-kilowatt horizontal Curtis turbine and generator, which furnishes electrical energy at 13,200 volts. Space has been provided for four additional units of the same capacity, as demands may be made. At the present writing, this is the largest seven-stage horizontal steam turbine that has been installed in a power plant by the General Electric Company, although several of larger capacity are being constructed; it is illustrated in Fig. 2. With the exception of the seventh stage, the machine is built along similar lines to the five- and six-stage turbines.

The unit is self-contained. Oil is kept in circulation from an oil tank cast in the base of the turbine frame and is supplied to the bearings at a pressure approximating 15 pounds per square inch. The bearings are cooled by water circulating in copper coils which are embedded in the babbitt bearings. The turbine is connected to a Worthington surface condenser which has a cooling surface of 10,000 square feet. It is located in the basement under the turbine and connection is made by the usual copper expansion joint. Water is supplied by gravity from a canal by means of an iron flume and escapes to a stream below the power house through a concrete flume. This eliminates the expense and trouble of operating a circulating pump.

On the turbine-floor level are located the exciter and air-pump units. The exciter set consists of a Curtis turbine di-

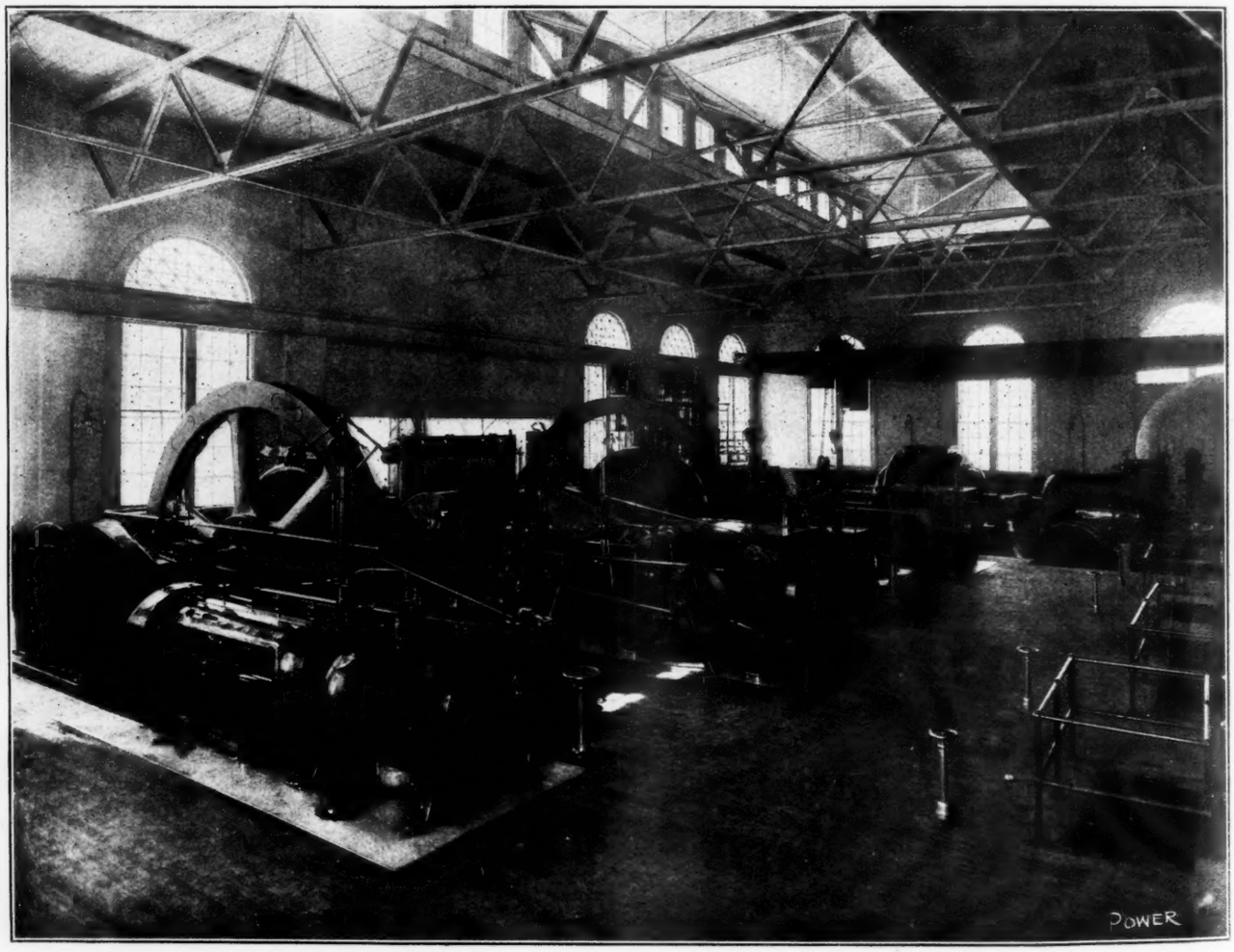


Fig. 1. Engine Room of the Worcester Consolidated Street Railway Company's Plant

rect coupled to a General Electric 125-volt direct-current generator. The turbine is of 75 kilowatts capacity and operates at a speed of 3300 revolutions per minute. The air-pump unit has 10 and 22 by 18-inch cylinders and main-

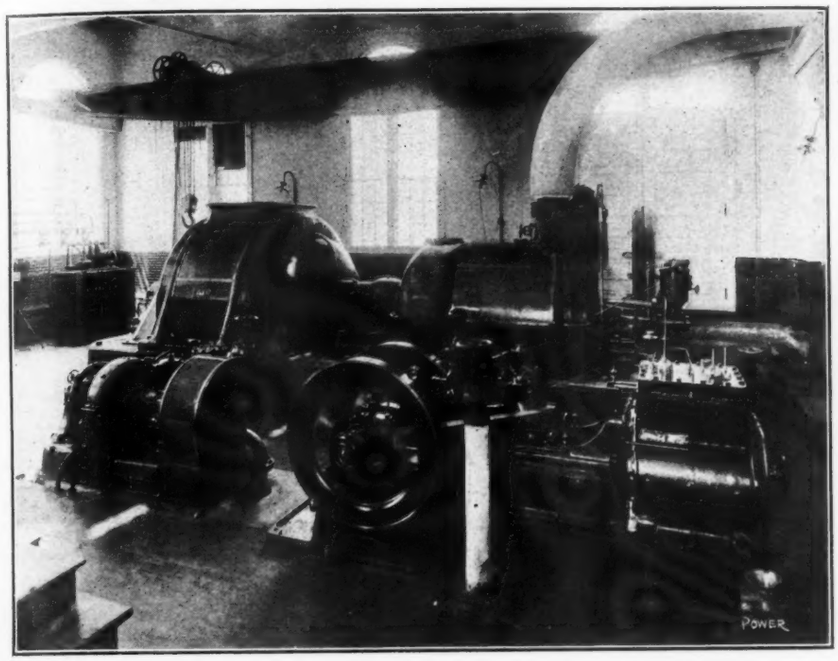


FIG. 2. VIEW OF TURBINE UNIT AND AUXILIARIES

tains a vacuum of 29 inches on the condenser.

The turbine generator is of the standard type, three-phase alternating current. The rotor is ventilated by means of fans secured to the revolving field. Air is taken from the outside of the building through a concrete duct built in the foundation and is carried to the machine at as low a temperature as possible. The high-tension switchboard is located on a raised platform at one end of the turbine; the main switch is electrically operated. On the switchboard is mounted the necessary indicating devices and recording instruments. Back of the switchboard are the choke coils and lightning arresters.

BOILER ROOM

The boiler room has been altered and enlarged. The old return-tubular type of boilers has been removed and four 850-horsepower Edge Moor boilers are now installed. Each is fitted with a Foster superheater, which superheats the steam 150 degrees. The steam pressure carried is 200 pounds per square inch. Each boiler is fitted with two Murphy stokers.

These boilers are housed in a building that is 100 feet long, 15 feet 6 inches wide, and 40 feet high, and has a monitor roof. Under the boiler-room floor there is an ash tunnel 145 feet long, which is constructed of reinforced cement. This tunnel terminates in an ashpit that is 25 feet deep and 10x16 feet inside dimensions. Fig. 3 shows the arrangement of the boilers.

Incidentally, it may be said that these Edge Moor boilers are the largest of the type ever installed in New England. They

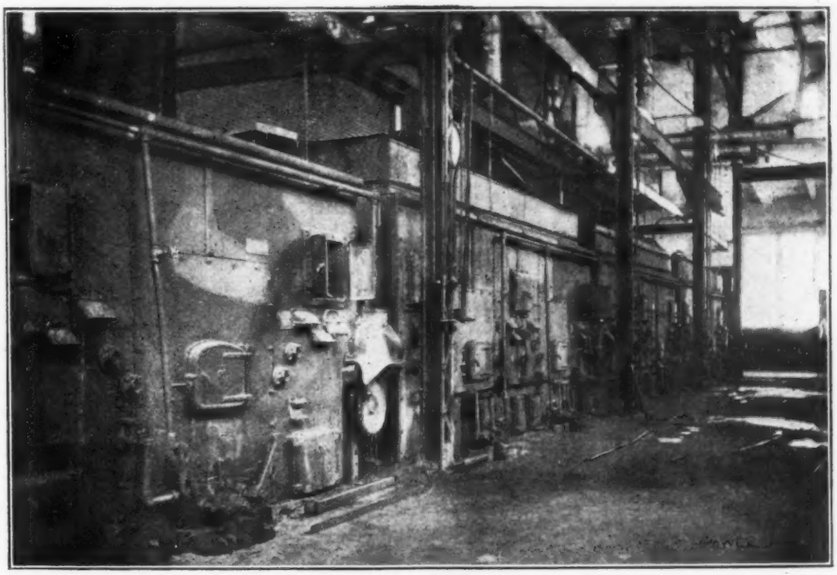


FIG. 3. ARRANGEMENT OF THE FOUR EDGE MOOR BOILERS

are of the four-pass type. These boilers are not equipped with economizers, but provision has been made for installing them on top of the concrete smoke flue which extends from the back of the boilers to the brick stack. This concrete flue, contrary to the general practice, is placed on the floor level, which gives ample opportunity for installing economizers later on. This flue is lined with firebrick and connects the boilers with a 225-foot Kellogg sectional radial-brick chimney having an internal diameter of 12 feet.

Double piping is supplied in the boiler room, and both the feed pipes and the steam lines are designed, not only with a view of extending the length of the boiler plant, but also of connecting to a second row of boilers at some future time. The feed water to the boilers is passed through a Wheeler heater of the closed type, and is pumped by means of two Wheeler heavy-duty boiler-feed pumps.

FUEL

Coal is delivered to the yard in carload lots, and is dumped in a pile under a high trestle that is 350 feet in length. An electric locomotive draws the cars 1500 feet over a siding from the main railroad track, and after the coal is dumped, it is hoisted by means of a two-ton bucket operated by a McMyler traveling locomotive, which dumps the coal into a hopper of a crusher that has a capacity of 125 tons. The arrangement is shown in Fig. 4.

From the lower hopper of the crusher the coal descends into a Larry coal car, which operates on a track extending over the top of the furnaces. The car discharges the coal wherever needed. The ashes from the grates drop into a concrete tunnel under the furnaces into a car which deposits the ashes into a receiving pit outside of the building. It is then taken by the bucket of the locomotive train and deposited in cars on the trestle and is then drawn away.

SUBSTATION

The transmission lines are carried a distance of six miles to a substation that is located at Worcester, Mass. They

consist of two three-phase lines of No. 0 stranded wire. These lines are capable of carrying a voltage of 33,000. The transmission lines enter a brick lightning-arrester tower, where choke coils, disconnecting switches and lightning arresters are located. From the tower the wires pass under Madison street through underground ducts to the substation, which is made fireproof throughout and is constructed with a skeleton of steel with walls of brick and concrete. The windows, sashes and casings are also of steel, no wood being used in the construction of this building.

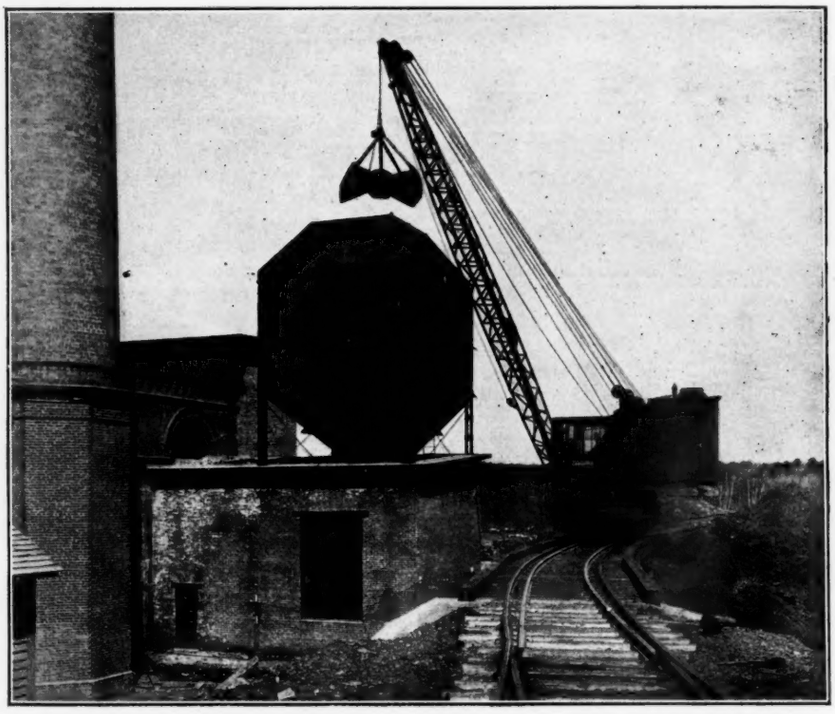


FIG. 4. COAL-HANDLING TRAVELING LOCOMOTIVE

This is said to be the largest substation in New England. The building is 144 feet long, 35 feet wide, and is 60 feet in hight. There are two floors and a basement, the first floor being 27 feet high, the second floor 26 feet. A 20-ton electric crane has been installed in the converter room, and one of 10 tons capacity in the second story. The supply circuit from the lightning-arrester tower enters the basement in two insulated lead-covered cables, which are carried to the top of the building where they connect with the busbars. In this same room there are four oil switches, which are operated from the switchboard. These are shown in Fig. 5.

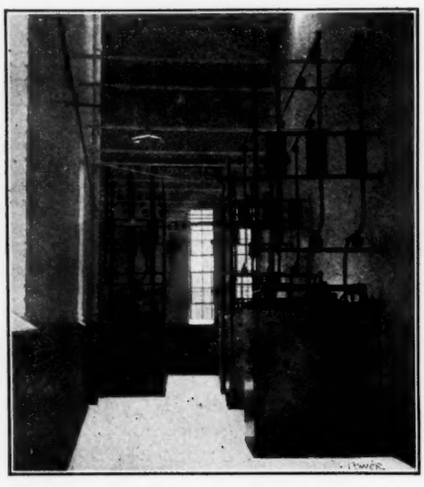


FIG. 5. LIGHTNING ARRESTERS AND OIL SWITCHES

A separate room on the second floor contains the transformers, which are shown in Fig. 6. They are arranged in banks of three over a large concrete duct. Each rotary converter is served by one of these banks. Each is connected to a motor-driven blower which draws air from the duct below and drives it through the transformers to cool them. Each transformer has a capacity of 500 kilowatts and steps the voltage down from 13,200 to 430, the potential at which it operates the rotary converters.

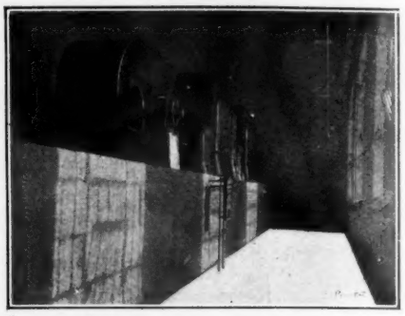


FIG. 6. SECTION OF THE TRANSFORMER ROOM

These two converters are located on the ground floor, as shown in Fig. 7. They are each of 1500 kilowatts capacity. Space has been provided for the addition of three more converters with the necessary transformers and oil switches. Each machine has its separate starting switchboard, which is on the opposite side of the building from the main switchboard. This panel contains the main rotary switch, the reacting switch and the push button controlling the oil switch. A constant voltage of 600 is transmitted from the busbars to the outgoing lines.

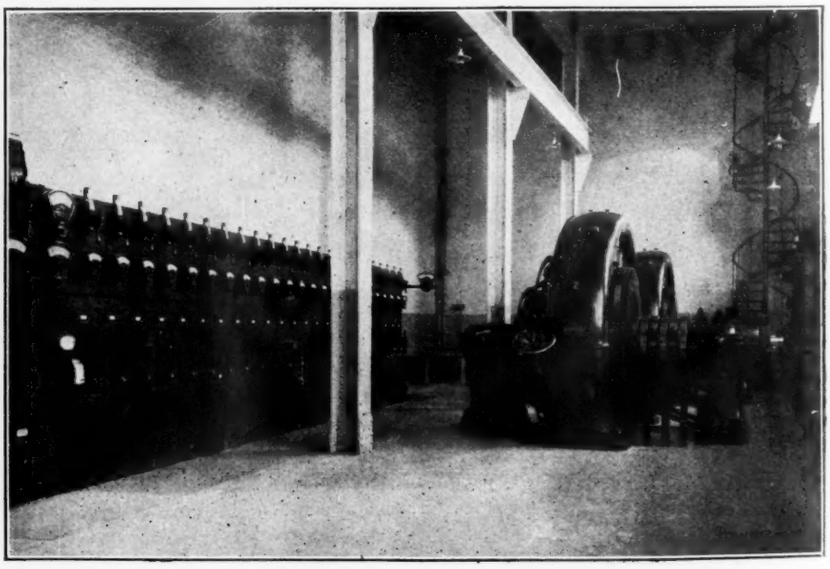


FIG. 7. CONVERTER ROOM, SHOWING THE TWO 1500-KILOWATT ROTARY CONVERTERS

The main switchboard has 27 panels: One station-instrument panel, two main rotary panels and a separate panel for each section of the feeder system, the

city wiring having been rearranged for this purpose. This substation is the center of distribution, as the outgoing current from the rotary converters and the incoming current from the Freemont street power station are connected in parallel at the switchboard and switched onto the various lines.

Directly under the rotaries, in an open space in the foundation in the basement, the negative and equalizer buses are placed. Several lines of underground return wires enter through the basement walls and are connected to the negative busbar.

The substation is located at a point practically in the center of the city, which makes the distribution of current with but small loss a possibility.

The Effect of Vacuum at an Altitude

In a recent issue of POWER the question was asked, "At a hight of a mile is the vacuum in an engine cylinder as effective as at the sea level?"

And answered, "It is."

In an effort to be laconic the editor who wrote the answer failed to put himself into the mental attitude of the man who wrote the question. If the question asked no more than if a given force is just as effective to move a piston in Colorado as in New York his answer is right, but the question is not worth answering. Adding twenty inches of vacuum will add, in round numbers, ten pounds to the mean effective pressure, and this wherever the engine may be, but this is too obvious to be taken as the point in the question. The atmospheric line from which it is reckoned has slipped downward at the higher altitude.

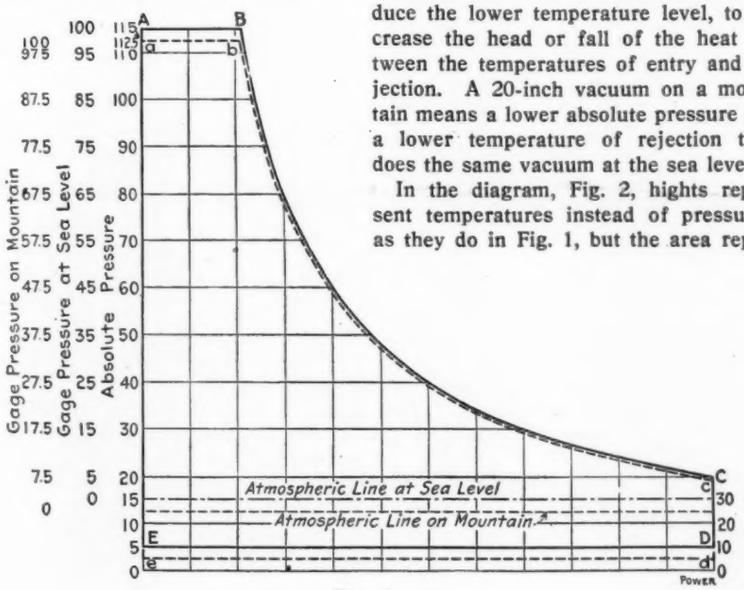


FIG. 1

Suppose an engine with an initial pressure of 100 pounds gage and a vacuum of 20 inches to be run, first with a 30-inch barometer, as there might be at the sea level, and then with a 25-inch barometer, as there might be at the altitude of a mile. To simplify the matter, since we are not after absolute results, assume 2 inches of mercury to be equal to one pound pressure.

Then at the sea level with the 30-inch barometer the atmospheric pressure would be 15 pounds and the absolute initial pressure 115 pounds per square inch.

With a 20-inch vacuum the absolute back pressure in the cylinder would be $30 - 20 = 10$ inches of mercury, or 5 pounds.

The ideal diagram would be *A B C D E* of Fig. 1, which, with a ratio of expansion of 6, gives a theoretical mean effective pressure of 48.5 pounds.

On the mountain, with the 25-inch barometer the atmospheric pressure would be 12.5 and the absolute initial pressure 112.5 pounds. With a 20-inch vacuum the back pressure in the cylinder would be $25 - 20 = 5$ inches of mercury, or 2.5 pounds absolute.

The ideal diagram would be *a b c d e*, represented by the dotted lines, and, with six expansions as before, would give a mean effective pressure of 49.8 pounds; 2.7 per cent. more than in the case of the same engine with the same initial pressure (gage) and the same vacuum at the sea level.

The effect of the condenser is to reduce the lower temperature level, to increase the head or fall of the heat between the temperatures of entry and rejection. A 20-inch vacuum on a mountain means a lower absolute pressure and a lower temperature of rejection than does the same vacuum at the sea level.

In the diagram, Fig. 2, hights represent temperatures instead of pressures, as they do in Fig. 1, but the area represents energy just as does the area of the other diagram. The diagram should be plotted with absolute temperatures, so that its real base is $460 + 338 = 798$ units below the level *A B* and the area of the whole diagram would represent the energy in the form of heat which must be put into a pound of water to make it into a pound of dry saturated steam at the given pressure. The area *A B C D* shows how much of this heat a perfect engine, working in a Rankine cycle between the limits 338 and 162 degrees (100 pounds initial and 20 inches vacuum at 30-inch barometer), could convert into mechanical energy as against that convertible by a similar engine working between the limits 336 and 135 degrees (100 pounds initial and 20 inches vacuum with 25-inch barometer), as shown by the area bounded by the dotted lines.

A Dangerous Bag

BY EDWARD T. BINNS

A venerable engineer recently related the following interesting incident of a dangerous case of bagging:

In taking charge of an old plant that was considerably run down, the boilers were found to be badly scaled. A barrel of good boiler compound was procured. Orders were given the fireman to use it sparingly until after the first or second cleaning; then to increase the amount until the scale should be removed. Instead of paying attention to these directions, the fireman got the order of proceeding reversed and for the first few days fed the compound in large amounts.

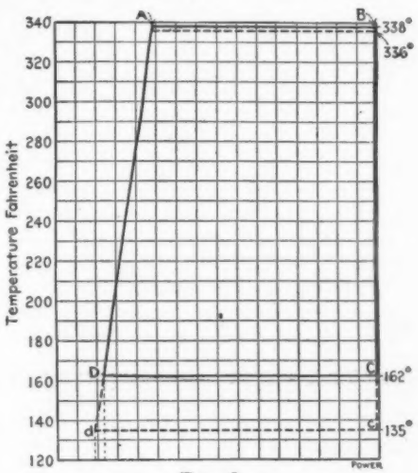


FIG. 2

At the end of the third day he called the attention of his chief to what seemed to be a leak in the boiler plate over the fire. An effort was made to run the boiler until Sunday but, the leak growing worse, it became necessary to shut down the boiler. Upon opening it, an accumulation of scale sufficient to fill a nail keg was found directly over the fire. The plate under this deposit had burned and bagged to a distance of 5 inches and over an area about 15 inches in diameter. The metal was drawn out to the thinness of brown paper and several small openings through the metal were in evidence. While the accumulation of scale caused the burning, it apparently stopped the holes for the time being and saved the boiler.

A horseshoe patch was put on and the old boiler is still in service.

Letters Patent for Inventions*

By D. Howard Haywood

A general discussion of patent rights and the protection they afford; also some useful hints as to the scope of the claims to be made in applying for a patent.

*From a paper delivered before the American Society of Mechanical Engineers, at New York on May 9.

There is much confusion in the mind of the average man as to the nature of the rights conferred by letters patent of the United States. Upon their face they grant to the holder, for a specified term of years, "the exclusive right to make, use, and vend" the invention claimed therein. This would seem to grant to the owner the right to make, use, and vend the invention, coupled with the right to exclude others from so doing. Such, however, is not the meaning at all. Letters patent grant no right to make, use, or vend an invention, but only the right to prevent others from doing so, the so-called exclusive right being merely the right of exclusion. If the grantee has the right to make, use, and sell the invention, at the time he receives the patent, then the patent grant makes that right an exclusive one; but if he does not have that right at such time, the patent does not give him such right, but merely the right to exclude others therefrom.

This will be understood best by citing a concrete example. Assume A to be the original inventor of the steam engine; he has a natural right to make, use, and vend the same, regardless of any patent right. He, however, applies for and obtains a broad patent thereon and receives the right to exclude others from exercising the right which they would otherwise have had of making, using, or selling steam engines. Now assume that B at some time later invents a specific form of rotary steam engine, for the novel features of which he obtains a patent. At the time of obtaining the patent, however, A's patent is in force; hence B has no right to make, use, or vend a steam engine of any kind. B's patent gives him no right in this connection, for if it did the effect would clearly be in abrogation of A's rights of exclusion, already acquired. B's patent grants him the right to exclude everyone from making, using, or vending the specific form of rotary engine invented by him, and nothing more; he can prevent others, including A himself, from making, using, or selling the rotary steam engine, but having no right to the exercise thereof, he obtains none in his patent. It is to be noted also that B's right to exclude A from making the rotary steam engine that B invented, is in no way inconsistent with A's patent right.

The result of the foregoing may seem somewhat anomalous, but it is no less true that during the life of A's patent, neither A nor B can make, use, or sell rotary steam engines, except by permission of one from the other. Failing such permission B can only wait until A's patent right has expired, whereupon he will be free to exercise his natural right, and for the remainder of the term of his own patent will likewise be able to exercise his legal right of restraint against others.

Novelty Distinguished from Infringement

When application is made to the Government for letters patent of the United States, a search is made by the Government solely upon the question of novelty. The applicant for a patent right describes and claims what he considers he has invented, and the Government, through its officials in the Patent Office, proceeds to search through prior publications, records and patents, in an endeavor to find anything upon which such description and claims can be read, and if found, B's application is refused. In the example just given, however, there is no disclosure by A of any rotary steam engine, but merely (say) of a reciprocating steam engine, and it being assumed that no disclosure of a rotary steam engine is found elsewhere, the patent sought for by B is granted to him. The fact that A in his application claimed, and in his patent was given, an exclusive right in relation to all forms of steam engines, is not taken into consideration by the Patent Office at all. A search is made for the specific thing that B has disclosed and is claiming and as this is not found, a patent is granted to B.

Patent Rights Transferable in Whole or in Part

The holder of a patent may remit that right to one or more persons, firms or corporations at will. There are in general three ways of accomplishing this result: (*a*) by assignment, (*b*) by territorial grant, (*c*) by license. Assignments may be of the entire patent right held by the original grantee, or of a part thereof. If of the entire right the situation is simple, the assignee merely being substituted for the original grantee, in which case the assignee assumes every right the original grantee had at the time he made the assignment. There is provision made for recording such assignments, and a statute provides that when recorded within a specified period, they become and constitute constructive notice to all of the transfer of title of the patent. If, on the other hand, the assignment conveys only a part of the right granted by the patent, the situation is not nearly so clear and is very often misunderstood.

Assume that *A*, the original grantee, assigns to X an undivided one-half interest in the patent, such assignment being unaccompanied by any partnership agreement. A has now broken up the complete right of exclusion and is sharing it with X. But as the right of exclusion necessarily carries with it the right of remission thereof, it follows that A and X can now, each of them, and the one independently of the other, remit that exclusion so far as anyone else is concerned, and that neither can interfere with the action of the other in this respect. The "exclusive right" or right of exclusion is thus utterly broken up and lost unless A and *X* act in concert. Furthermore, in an assignment unaccompanied by any restrictions as to a partnership agreement, it does not matter what proportion of the patent right is nominally assigned. An assignment of a one-hundredth part conveys exactly the same right in this respect as one-half or ninety-nine hundredths.

But few words need be said in relation to territorial grants and licenses. These instruments do not convey an undivided interest in the patent right, but the exact nature of the interest conveyed is dependent in each case upon the wording of the particular instrument, the nature of such interest usually being set forth in specific terms therein.

Part ownership of a patent right may also result from joint invention. In such a case application must be made in the name of the joint inventors and the patent is granted to them jointly. Each owner may operate independently of the other and may grant rights under the patent without the consent of the other.

As it is the claims which determine the breadth and scope of the patent protection granted, it follows that their wording is of extreme importance. It is upon the skilful drawing of the claims that the whole value of the patent depends. They should, where the nature of the invention permits, be broad and comprehensive, so that mere variations in structure will fall within them; yet they must not be ambiguous, uncertain or vague, for they would then be liable to be declared invalid by the courts. Also the claims must not touch upon any previously invented structure, for in such case they would be anticipated thereby and would have no validity. The first requisite, then, in the drafting of a claim, is an accurate knowledge of what has been previously accomplished in the same or similar lines,

a knowledge, as it is aptly called, of the state of the art.

The next requirement is a true appreciation of the problem that the inventor has solved. It is not sufficient that one drawing a claim shall merely understand the specific structure for which patent protection is to be acquired, for in such case he would not be in a proper position to distinguish between the essential and nonessential features thereof. To illustrate this, conceive an appliance placed upon an engine such as would operate in connection with the valve mechanisms for both the inlet and the exhaust of steam. For convenience the inventor might apply it in this way, yet actually his problem is completely solved by the application of the device to the means for admitting steam. A failure to appreciate the fact that the application to the means for controlling the exhaust of the steam was mere surplusage, or at best a convenience, might lead to the drawing of claims in a way that would prevent others only from applying the mechanism to both inlet- and exhaust-valve mechanism, leaving them free to place it upon the inlet-valve mechanism alone, and thereby actually to attain the benefits of the invention.

After broad claims have been drawn such as comprehensively cover the invention generally, in such terms as to include all reasonable variations of the structure, it is then wise to insert specific claims: First, to the general specific structure shown, and, second, to any specific part of the structure such as may be deemed to be of particular importance.

Letters patent for inventions may cover: First, an apparatus, machine, structure or a device; second, a process or method; third, a composition of matter, such as a chemical compound, and, fourth, a design.

Under the first heading come such combinations of elements as are included, for instance, in steam-heating systems, steam engines, automatic machinery, etc., including practically everything which comes under the term mechanical arts. Claims drawn to these structures are in form for a combination of elements.

The Supreme Court of the United States has laid down the doctrine that the elements of claims must combine together to a single unitary result in order that the claims be patentable. The most famous case perhaps in this connection is the Faber pencil case in which a claim covering the ordinary form of lead pencil in use today, with the rubber tip thereon for erasing purposes, was held unpatentable. A patent had been actually granted upon this device but the Supreme Court of the United States declared it to be invalid. The Court said in effect that the pencil and the rubber each operated independently of the other as each had theretofore operated and that the mere assembling of them together was for convenience only, and did not constitute an inventive act. When so aggregated, the pencil was still used as a pencil and the rubber as an eraser; the pencil and eraser did not combine together for any single unitary result, but, on the contrary, were separately employed for independent and individual results. Hence, for a claim to be valid, all of its elements must combine together for a final result which is different in kind from that which would have resulted from the use of these elements individually or in individual subcombinations.

Under the second heading come processes or methods, and in this connection it is quite difficult to say with any degree of certainty what is capable of being protected by a patent right, and what is not. Anything new in which there is an elemental or chemical action is capable of this protection; while going to the other extreme, anything which is the mere function of a machine is not capable of such protection, the only possible way of protecting the process or method carried out in a machine being to patent the machine itself.

The requirement for patents under the third class, other than novelty, is that they constitute something more than a mere mixture of known ingredients, with no new result other than that which would naturally follow from such a mixture.

Design patents are granted for something new in ornamental configuration. Parts that have a new form merely for some mechanical purpose are not capable of protection under the design branch of the patent law, the requirement being novelty in ornamental configuration without regard to utility.

Fatal Economizer Explosion

By John S. Leese

An explosion of a Green's economizer resulting in the death of one man, recently occurred at the Pilkington Tile and Pottery Works, Clifton Junction, England.

The economizer was connected to a Lancashire boiler for which it heated the feed water and was installed in 1897. It had been periodically examined since its installation by the representatives of the makers and was apparently in good condition up to the time of the explosion. In the engine room was hung a list of instructions issued by the makers and the following paragraph was printed thereon in red ink under the caption "Repairs:" "When these are being executed it is imperative that the pressure be taken off and the economizer shut down by closing the inlet and outlet dampers and feed valves, allowing the heat to pass through the spare flue. Under no circumstances should any of the joints be interferred with while under pressure."

Howard was the night and Horsfield the day attendant of the boiler and economizer and the circumstances of the accident resulting in the death of Horsfield were as follows: At 11 p.m. on the day before the explosion, Howard, who was on duty, noticed that the second cover joint from the inlet end of the lower branch pipe was leaking. He thereupon disconnected the economizer from the boiler and emptied it by means of the blowoff valve. He then removed the cover and remade the joint with rubber and canvas, and, after replacing the cover, reconnected the boiler to the economizer. At five o'clock the next morning he relieved the economizer of pressure by lifting the safety valve, and, with a spanner 18 inches in length, tried the nuts on the remade joint. He then placed the spanner on a branch pipe near the cover and lowered the safety valve. Howard was relieved at six o'clock by Horsfield to whom he related what he had done to the cover, telling him where he could find the spanner in case it should be again necessary to tighten the nuts. At a few minutes past seven the explosion occurred and Horsfield was found in the space occupied by the lower branch pipe of the economizer. The spanner was found 8 feet away from the place where Howard had left it, the cover referred to was on the ground and one of the two bolts which had held it was found to be broken.

The cover was held by two $\frac{5}{8}$-inch bolts. About three years ago Messrs. Green replaced, as standard on their economizers, two $\frac{5}{8}$-inch bolts with four $\frac{1}{2}$-inch bolts and later still these four bolts were replaced by four $\frac{5}{8}$-inch bolts. The boiler was worked at a pressure of 100 pounds per square inch and the economizer at a pressure of 110 pounds per square inch. According to the statement of the head of the inspection department of Messrs. E. Green and Sons, the number and thickness of the bolts had not been increased on account of any doubt as to the safety of using two bolts, but simply to guard against the possibility of employees ignoring the rules. He stated that two bolts were strong enough to withstand the pressure, but that, if one of them was sheared off, the other would not suffice to hold the cover on. With four bolts, in the event of one of them being broken, the other three would hold the cover in place. The above mentioned instructions had been issued to all economizer users in 1903 as a result of an accident that had occurred in 1902 to an economizer.

The cause of the fatality was, apparently, the breaking of the $\frac{5}{8}$-inch bolt by tightening it with the 18-inch spanner. The moral of the accident is, therefore, "When rules are issued by the manufacturers of power-plant apparatus, stick to them. They are likely to know more about what it is safe to do and when to do it than you are and they will not put obstacles in the way of their sales department by issuing uncalled-for instructions."

Symonds—Emergency Engineer

By F. L. Johnson

Some of the experiences of a bright young engineer who opened a "first aid" to injured machinery consulting office from which he directed personally conducted repair and replacement jobs.

John Symonds had a small office near the business center of a New England manufacturing town. On the glass of the single large bow window, by which he used to sit and think, or just sit if he had no thinking to do, was written in modest gold-leaf letters,

JOHN SYMONDS
EMERGENCY ENGINEER

I had known Symonds a number of years. In early manhood he was one of the engineers in the fire department of his city. I called on him to renew an acquaintance which had been interrupted by my absence from the East. He had not changed much, and except for a sprinkling of gray in the hair about the temples, twenty years had not altered his appearance. Of medium hight and rather lean, he looked like an athlete in perfect condition and his keen, alert glance was friendly and somewhat inquiring as we shook hands. After the usual greeting had been exchanged I said, "Emergency Engineer, what is that?"

"Oh," he said, "it is really a long story but I can make it short by just touching the high spots for I do not think you will care for the minor details. The fire department is no place for a live engineer. It is a soft job at fair pay, but the average man will go down hill both mentally and physically from the day he enters the service. I recognized this early in the game and got out. There was no job waiting for me so I advertised in a small way among the engineers and owners, that I was ready to substitute in engine rooms during the vacation, sickness and emergency absences of the regular man. I got plenty of work at the prevailing rate of pay. In many plants I found many opportunities to improve the operating conditions, to do quick repair stunts and a lot of first aid to injured machinery work.

"Somehow I got the nickname of Emergency Engineer, which stuck and as I had some ability in getting out of close corners I began to get calls to look after repair jobs, make changes and the like, which, with substituting, kept me pretty busy. I rather liked the title of Emergency Engineer and determined to earn it, so I stopped substituting and opened this office.

"Owners wanted advice and wanted work done. I was long on doing work but short on giving or selling advice. I loved to do things my own way a great deal better than telling how they should be done and though I could do a fair business as a consulting engineer within my limits I prefer that work which gives me physical exercise and trains my hands along with my brain. I have my office, congenial work and make a good living. What more can life offer?"

"But," said I, "what work do you do? What kind of jobs come your way?"

"I do anything which anybody wants done in a hurry in a steam plant. Why! last week—" Just here the telephone bell rang. After answering it he said,

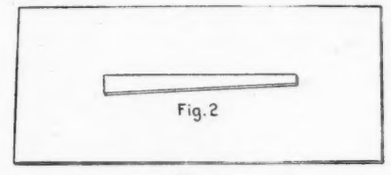


Fig.1

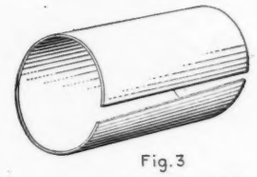


Fig.3

Fig.4

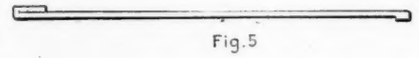


Fig.5

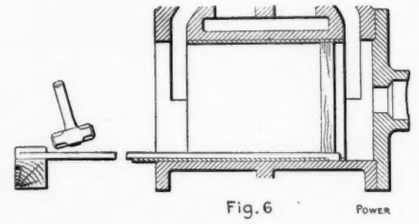


Fig.6 POWER

"You asked what I do. A call has just come from Brown's that the air pump on the surface condenser has stopped. The engineer cannot start it and the engine will not carry the load noncondensing. I do not know what is wrong but as it is only around the block you can go with me and see what is wrong."

We went. The piston had stopped at about two-thirds of the stroke. Symonds pushed the valve to the other end of its stroke and opened the throttle slightly. The piston moved back to the end of the cylinder, the valve reversed and the piston started on the return stroke.

"Steam end apparently all right," he said softly, as he closed the throttle. He directed the engineer to take off the cylinder head on the water end. This showed why the pump stopped. The water piston was and probably had been for some months guiltless of packing. One of the set out segments had dropped to the bottom of the cylinder and had ploughed through the bushing near mid stroke and a sliver had rolled up, against which the piston struck and stopped.

Whistling, "It Beats All What You See When You Don't Have a Gun," Symonds got into overalls, cut out the obstruction, dismantled and took out the piston. Finding a short crowbar he drove it between the bushing and the cylinder wall at the worn part crimping it so that it was easily pulled out. He then calipered the cylinder. Next he went to a near-by carpenter shop and selected some soft-maple stock of about ½ inch thickness, from which with the band saw he made three packing rings for the piston. These he took back to the plant, put the piston on the rod, put in the wood packing, closed the cylinder and started the pump.

When the exhaust from the engine was turned into the condenser and everything seemed to be going along all right he said to the engineer, "This will run in good shape for months but I will be here Saturday at twelve o'clock to put in a new bushing and I will need one man with a sledge hammer to help."

On the way back to the office he said, "this is an example of the kind of work I have to do. It is my first call to handle a job of this nature. It goes without saying, however, that if all places were filled by first-class men I would not have much to do beyond a little substituting. But there are not enough, first-class men to go around and so long as such miserable wages are paid for engineers' services there will be little inducement for anyone to become an engineer."

I did not reply, but instead I said, "that pump was made out in Wisconsin and you promised to put in the new bushing Saturday. Today is Thursday. Do you expect to get it by telephone?"

"Well, not exactly, but I expect to make it tomorrow afternoon. Come around and take lunch with me and then we will make the bushing together if we can find any sheet brass suitable for the job."

After luncheon the next day he said, " that pump cylinder is 12⅜ inches in diameter and the piston is about 1/32 of an inch less than 12 inches, which shows that the bushing should be 3/16 of an inch thick and 16 inches long. It will take a strip about 39 inches long to go

around the inside of the cylinder. It will take up some in rolling so we will go over to the boiler shop and see what we can find."

At the boiler shop some sheet brass 3/16 inch thick was found and from it he had two pieces cut. One piece 16 inches wide and 37½ inches long, one end of which was afterward trimmed diagonally, see Fig. 1, and another 20 inches long by 1 inch at one end and 1¾ at the other, see Fig. 2.

The larger piece he had rolled to approximately a diameter of 12 inches, Fig. 3, and had the two pieces sent to the plant. While at the boiler shop he also had made from a bar of inch octagonal steel the two tools shown in Figs. 4 and 5.

After leaving the boiler shop we parted at the corner after he had said that if I still felt interested I would do well to come around to the plant the next day and see the job finished.

As Symonds suggested I arrived at the plant soon after 12 o'clock and found him already at work. The pump had been dismantled and he was driving the split bushing into the cylinder with a hide-faced hammer. When in place there was a tapering slot or gap where the sheet had been trimmed. Into this slot he drove the wedge-shaped strip until the rebound of the hammer showed that it was solid. This forced the side of the bushing outward against the cylinder wall. Then with a light hammer he "sounded" the bushing in several places to determine whether the contact between the bushing and the cylinder was perfect. Every spot touched gave forth the same sound, proving that the wedge had driven the bushing outward and that it was really expanded into perfect contact.

He then measured the distance from the small end of the wedge to the inner end of the bushing, which proved to be about an inch. He then took the bar shown in Fig. 4 and put the hook over the end of wedge and drove a strut of wood between it and the side of the bushing, as in Fig. 6, and with a block under the outer end of the bar to support it, the helper with the sledge struck on the gib of the bar which, with a few blows, pulled out the wedge.

This, after a thorough inspection, was dressed along one edge, narrowing it about a thirty-second of an inch which, according to Symonds' calculations would allow it with the same amount of driving to enter three-quarters of an inch further, leaving a quarter of an inch for the final driving. It was then narrowed slightly at the wide end to allow for the upsetting effect of the final driving. It was smeared on one side and both edges with a mixture of white lead and graphite to reduce the friction of driving.

After accurately locating the bushing and preventing a possible endwise movement from the effect of driving by a couple of distance blocks placed between the ends of the bushing and the inside cylinder head, the wedge was pushed into the slot and driven home with the drifting tool and sledge, Fig. 6. When the small end of the wedge came flush with the inside end of the bushing, the wide end was cut off flush with the end of the bushing.

The hard driving had raised a little bur or ridge along the joints which Symonds removed with a scraper. The parts were reassembled with new hot-water packing in the piston and the pumps tried, and as everything appeared to be in good working order we walked back to the office.

Seated by the window again Symonds, as he held a cigar in one hand and a match in the other said, "that little job was just what I needed. It gave me the necessary mental and physical exercise, which keeps me in condition. Sometimes nothing happens for a week and I have to take a cross-country walk to keep in shape. But that does not often happen. There are 206 steam engines in this town and I am sure to hear from most of them inside of a year. I do not keep a shop and have but few tools. I am always welcome to the use of any tools belonging to the shops in which I happen to be working."

Just here a man came in who wanted some advice about the purchase and repairs on an engine which had been slightly damaged by fire, so I took my departure after promising to look in on my next trip and see some more emergency repair work.

Driving Boilers at Economical Rates

By Alphonse A. Adler

A graphical method showing how the fixed charges, the cost of coal and the total operating cost of the boiler plant vary with the rate of driving.

The most economical rate of driving boilers, from the thermal and commercial standpoints, differ because the fixed charges are some function of the number of boilers in service, whereas the highest thermal efficiency occurs at a certain load per boiler and is independent of the number of boilers in service.

Before proceeding with the topic under consideration it might be well to define some of the terms used. The writer prefers the term "overall" efficiency to denote that efficiency ordinarily termed as "combined boiler and furnace efficiency." The efficiency of the boiler proper may be expressed as

$$\frac{\textit{Heat absorbed from combustible burned}}{\textit{Heat in combustible burned}}$$

and this ratio may be limited to one pound of combustible as its value is unaffected by the weight. The furnace efficiency may be expressed as the

$$\frac{\textit{Heat in the combustible burned}}{\textit{Heat in the combustible fired}}$$

This latter expression evidently indicates the combustible that is lost through the grate and that disposed of in the ashes. The product of these efficiencies gives the overall efficiency, or

$$\textit{Overall efficiency} = \frac{\textit{Heat absorbed from combustible burned}}{\textit{Heat in combustible burned}} \times \frac{\textit{Heat in combustible burned}}{\textit{Heat in combustible fired}} = \frac{\textit{Heat absorbed from combustible burned}}{\textit{Heat in combustible fired}}$$

From the foregoing it will be seen that the overall efficiency is easy to measure as it is the ratio of the total heat in the steam to the total heat in the combustible fired. The overall efficiency is the one plotted in Curve 1, which is the characteristic curve for water-tube and, probably, fire-tube boilers, under carefully guarded commercial conditions.

This curve shows the thermal efficiency of the boiler increasing to a maximum at about 3.25 pounds evaporation per square foot of heating surface per hour, then slowly dropping at higher rates of evaporation. Were only the thermal efficiency of importance, the most economical rate of driving would evidently be an evaporation of 3.25 pounds per square foot of heating surface. Consider first the heat absorption of the boiler, the heat transmission being a function of the time. At low rates of driving, the movement of the gases is slower; hence the transmission per unit of time is greater than at the high rates of driving. The water and the gas speeds are slow at low rates of driving, and the consequent absorption is low with a tendency to increase at higher rates of driving. The furnace operates at low efficiency at low rates of driving, increasing up to some limit as the rate of driving increases, due to better control of the air supply and consequent higher temperatures. The stratification of the combustion products is more marked at the low rates of com-

bustion, as each particle has a well defined path through the boiler, and the formation of CO in the presence of O is readily detected. As soon as the speed

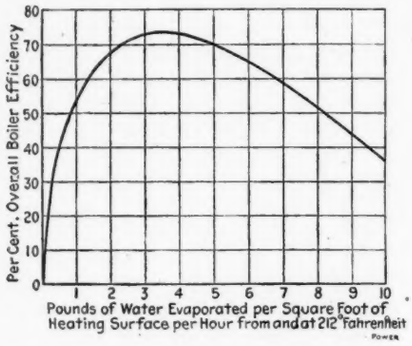

Per Cent. Overall Boiler Efficiency
Pounds of Water Evaporated per Square Foot of Heating Surface per Hour from and at 212° Fahrenheit
POWER

FIG. 1. EFFECT OF DRIVING UPON OVERALL EFFICIENCY

of the gas increases, the eddies formed give the gas a turbulent action and a more intimate intermingling results. The overall efficiency is the sum of these individual factors, some of which increase as the rate of driving increases, while others decrease under the same conditions.

In the analysis for a given plant, a curve similar to curve No. 1 might be drawn if accurate results are desired; otherwise, the one shown may be assumed as typical. For example, assume the following values:

Boilers at $15 per horsepower, or $4500 for a 300-horsepower boiler; floor space, 600 square feet per boiler; fixed charges on boiler house,* $1 per square foot, or $600 per boiler per annum; interest, depreciation, maintenance and labor at 20 per cent. of cost of boilers, $900 per boiler per annum; coal at $3 and $6 per net ton; heat value per pound of combustible, 14,600 B.t.u.; steam consumption, 24,000 pounds per hour; steam pressure, 150 pounds gage; feed-water temperature, 200 degrees Fahrenheit.

Service and conditions of operation as follows:

Coal at $3 per ton, 8 hours per day of 300 days per year; coal at $3 per ton, 4 hours per day of 300 days per year; coal at $6 per ton, 8 hours per day of 300 days per year; coal at $6 per ton, 4 hours per day of 300 days per year.

*These values represent the upper limits and are much higher than those met with in the average plant. In the curves, however, the actual conditions for any plant may be found by interpolation.

Adding the $900 for interest on the boilers, to the $600 for fixed charges on the building, the total fixed charge is $1500 per boiler of 300 horsepower. The assumptions are somewhat crude due to the 4- and 8-hour schedules, thereby ignoring coal for banking and variations in efficiency with variations in load. Present central-station practice indicates that reasonable results are arrived at by granting these assumptions, refinements in figures being a matter of personal taste. For convenience in plotting the curves, the fixed charges are reduced to

$$\frac{1500}{300} = \$5.00 \textit{ per boiler horsepower}$$

or

$$\frac{5.00}{10} = \$0.50 \textit{ per square foot of heating surface}$$

The total steam per hour from and at 212 degrees Fahrenheit is

Steam at given pressure and feed temperature × *factor of evaporation*
= 24,000 × 1.0615 = 25,476 *pounds*

The number of boilers required at the most economical rate of driving from the coal standpoint alone is found from the expression

$$\frac{25{,}476}{3.25 \times 300 \times 10}$$

which figures out to be three boilers, allowing the customary 10 square feet of heating surface per boiler horsepower.

By reference to curve No. 1, the efficiencies at the different rates of driving can be tabulated as follows:

TABLE 1

Rate of driving in pounds of water evaporated from and at 212 degrees Fahrenheit per square foot of boiler heating surface....	1	2	3	4	5	6	7	8	9	10
Boiler efficiency.....	0.54	0.6775	0.73	0.73	0.70	0.65	0.5875	0.5175	0.44	0.36

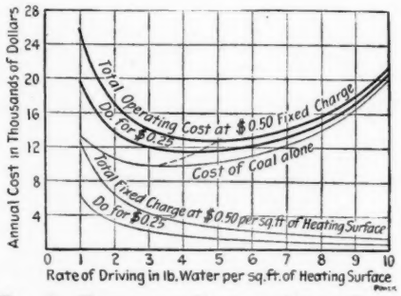

Annual Cost in Thousands of Dollars
Total Operating Cost at $0.50 Fixed Charge
Do for $0.25
Cost of Coal alone
Total Fixed Charge at $0.50 per sq.ft. of Heating Surface
Do for $0.25
Rate of Driving in lb. Water per sq.ft. of Heating Surface
POWER

FIG. 2. EFFECT OF DRIVING UPON TOTAL OPERATING COSTS. SERVICE, 2400 HOURS, COAL $3 PER TON; SERVICE, 1200 HOURS, COAL $6 PER TON

The annual cost of coal for a given plant will equal

$$\frac{(\textit{Steam per hour} \times \textit{B.t.u. per pound of steam} \times \textit{hours of service per annum} \times \textit{cost per pound of combustible})}{(\textit{Heat value per pound of combustible} \times \textit{boiler efficiency})}$$

This for eight hours operation per day, and coal at $3 per ton, is expressed in Table 2.

TABLE 2

Rate of evaporation, pounds of water per sq.ft. of heating surface per hour	Cost of Coal per Annum
1	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.54} = \$13{,}300$
2	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.6775} = \$10{,}600$
3	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.73} = \$\ 9{,}830$
4	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.73} = \$\ 9{,}830$
5	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.70} = \$10{,}200$
6	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.65} = \$11{,}000$
7	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.5875} = \$12{,}200$
8	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.5175} = \$13{,}900$
9	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.44} = \$16{,}300$
10	$\frac{25{,}476 \times 970.4 \times 2{,}400 \times 0.1765}{14{,}600 \times 0.36} = \$20{,}000$

In doubling the cost of coal it is necessary only to double the costs in Table 2, or, halving the hours of service, will be equivalent to dividing these costs by two.

TABLE 3

Rate of evaporation	Cost of coal per annum	Fixed charges at $0.50 per sq.ft. of heating surface	Total annual cost fixed charges at $0.50 per sq.ft. of heating surface	Fixed charges at $0.25 per sq.ft. of heating surface	Total annual cost fixed charges at $0.25 per sq.ft. of heating surface
1	$13,300	12,740	26,040	6,370	19,670
2	10,600	6,370	16,790	3,185	13,785
3	9,830	4,250	14,080	2,125	11,955
4	9,830	3,185	13,015	1,593	11,423
5	10,200	2,548	12,748	1,274	11,474
6	11,000	2,125	13,125	1,062	12,062
7	12,200	1,825	14,025	912	13,112
8	13,900	1,593	15,493	796	14,696
9	16,300	1,417	17,717	708	17,008
10	20,000	1,274	21,274	634	20,634

The annual cost of coal given in Table 3 is taken from Table 2. The fixed charges are determined as follows: At the rate of evaporation of 1 pound of water per square foot of heating surface from and at 212 degrees Fahrenheit, 25,476 square feet of heating surface are required. At a fixed rate of $0.50 per square foot of heating surface the annual charges become

$$25{,}476 \times 0.50 = \$12{,}740$$

For an evaporation of 5 pounds of steam per square foot of heating surface, the

number of square feet of heating surface is

$$\frac{25,476}{5} = 5,095$$

Again, at the fixed rate of $0.50 per square foot of heating surface the annual charge becomes

$$5,095 \times 0.50 = 2,548.$$

In this way all the values in the third column have been computed. By halving these values those in the fifth column are arrived at, this amounting to a fixed

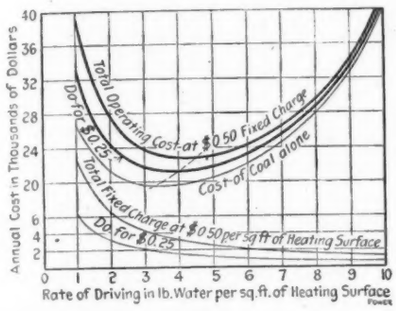

Annual Cost in Thousands of Dollars
Total Operating Cost at $0.50 Fixed Charge
Do for $0.25
Cost of Coal alone
Total Fixed Charge at $0.50 per sq.ft. of Heating Surface
Do. for $0.25
Rate of Driving in lb. Water per sq.ft. of Heating Surface
Power

FIG. 3. EFFECT OF DRIVING UPON TOTAL OPERATING COSTS. SERVICE, 2400 HOURS, COAL $6 PER TON

charge of 0.25 per square foot of boiler heating surface.

By adding the fixed charges to the cost of coal the values in the fourth and sixth columns are obtained, these representing the total annual operating costs. The values in Table 3 are plotted in curve No. 2.

By doubling the cost of coal and using the same number of hours of service, the values in the second column, Table 4, become just double those of the second column, Table 3. The fixed charges remaining the same at rates of both, $0.50 and $0.25 per square foot of heating surface, the values are arrived at as before. These figures have been plotted in curve No. 3.

Assuming 1200 hours of service per year instead of 2400 hours, with the coal costing $3 per ton, the values in the second column, Table 5, are obtained; these are one-half the values of those in the second column, Table 3. As before, the fixed charges remain the same, and their addition to the cost of coal results in the fourth and sixth columns, which are the total annual operating costs. Curve No. 4 shows this in its final form.

Some attention might profitably be directed toward the change in the most economical rate of driving. When the coal cost and hours of service are low the rate of driving should increase. On the contrary, should the cost of coal be high and also the hours of service, then the point of maximum boiler efficiency should be approached. Curve 1 shows that there are two points that can have exactly the same efficiency at altogether different rates of driving. For instance, 60 per cent. efficiency is attained when evaporating 1.3 pounds and also 6.8 pounds of water per square foot of heating surface per hour.

TABLE 4

Rate of evaporation	Cost of coal per annum	Fixed charges at $0.50 per sq.ft. of heating surface	Total annual cost fixed charges at $0.50 per sq.ft. of heating surface	Fixed charges at $0.25 per sq.ft. of heating surface	Total annual cost fixed charges at $0.25 per sq.ft. of heating surface
1	26,600	12,740	39,340	6,370	32,970
2	21,200	6,370	27,570	3,185	24,385
3	19,660	4,250	23,910	2,125	21,785
4	19,660	3,185	22,845	1,593	21,253
5	20,400	2,548	22,948	1,274	21,674
6	22,000	2,125	24,125	1,062	23,062
7	24,400	1,825	26,225	912	25,312
8	27,800	1,593	29,393	796	28,596
9	32,600	1,417	34,017	708	33,308
10	40,000	1,274	41,274	634	40,634

TABLE 5

Rate of evaporation	Cost of coal per annum	Fixed charges at $0.50 per sq.ft. of heating surface	Total annual cost fixed charges at $0.50 per sq.ft. of heating surface	Fixed charges at $0.25 per sq.ft. of heating surface	Total annual cost fixed charges at $0.25 per sq.ft. of heating surface
1	6,650	12,740	19,390	6,370	13,020
2	5,300	6,370	11,670	3,185	8,485
3	4,915	4,250	9,165	2,125	7,040
4	4,915	3,185	8,000	1,593	6,508
5	5,100	2,548	7,648	1,274	6,374
6	5,500	2,125	7,625	1,062	6,562
7	6,100	1,825	7,925	912	7,012
8	6,950	1,593	8,543	796	7,746
9	8,150	1,417	9,567	708	8,858
10	10,000	1,274	11,274	634	10,634

The dotted lines on curves 2, 3 and 4 pass through points of maximum economy. The dotted line is also useful in estimating the most economical rate at other than these assumed values for fixed charges. Furthermore, should the maximum boiler efficiency occur at, say, 4.25, instead of 3.25 pounds evaporation, the rate of driving would move in the same direction; that is, it would be about 1 pound higher than values obtained in curves 2, 3 and 4. Hence, even though the curves do not tell exactly the condition for any given plant, still with a little judgment, they may be of service in locating approximately the rate of driving for any plant.

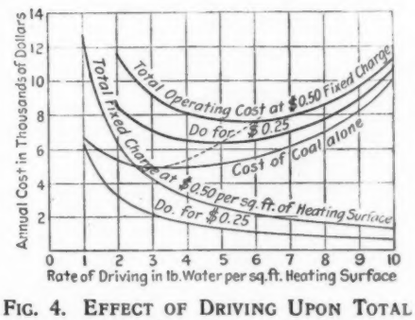

Annual Cost in Thousands of Dollars
Total Operating Cost at $0.50 Fixed Charge
Do for $0.25
Cost of Coal alone
Total Fixed Charge at $0.50 per sq.ft. of Heating Surface
Do. for $0.25
Rate of Driving in lb. Water per sq.ft. Heating Surface

FIG. 4. EFFECT OF DRIVING UPON TOTAL OPERATING COSTS. SERVICE, 1200 HOURS, COAL $3 PER TON

In conclusion it may be said that the curves apply only to such cases where no spare boilers have been installed. When this is the case, the interest on the investment goes on, whereas there may be somewhat of a reduction in the labor charge. Also, it is better to keep boilers in service when light loads are being carried, as the variation in furnace temperature affects the life of the settings and may thus increase the maintenance charge.

Danger of Fire from Steam Pipes

The quarterly of the National Fire Protection Association of Great Britain recently presented some interesting notes on the danger of fire from steam pipes. It is generally admitted that steam pipes in contact with wood will cause an occasional fire. There is considerable diversity of opinion as to the circumstances under which such fires may be expected to occur, but the conclusions drawn by a number of investigators who attempted to produce fires by bringing steam pipes into contact with various combustible materials were, that any steam pipe, no matter how low the pressure, would in the course of time produce charcoal and that when this stage was reached, positive danger existed. Charcoal is unquestionably subject to spontaneous ignition due to its peculiar ability to absorb from the air many times its own volume of oxygen. The combination of this oxygen with the carbon may take place with sufficient rapidity to raise the temperature to the ignition point. Furthermore, charcoal formed at a low temperature is known to have a low ignition point.

Some investigators seem to think that there is less danger from this source where steam is kept on a system continually than where it is on intermittently. The reason advanced is that when allowed to cool the charcoal has a better opportunity to absorb oxygen than if kept hot at all times.

There are two general methods of keeping steam pipes free from contact with combustible material, the first being through the use of an insulator, such as pipe covering, and the second by supporting them rigidly at a safe distance. Wherever pipes pass through concealed spaces the covering should preferably be carried for the entire length to avoid future contact with substances which may get into these spaces. On new installations solid covering and collars can be used; where the piping is already in place, split covering wired together and split collars make the partial taking down of piping unnecessary. If desired, metal supporting plates can be used at the ceiling instead of a collar.

The Cost of Industrial Power

By Henry D. Jackson

A rational discussion of the charges to be included in figuring the cost of industrial power, with special reference to the attempts of central-station men to boost these charges, as shown by Mr. Hibner's paper which appeared in the March 21 issue of Power.

It seems rather peculiar that all of the information available on power costs in industrial plants comes from the industrial engineers or sales engineers of the central power stations. It may be that these figures come from such sources because these people are the only ones sufficiently interested to go into the matter carefully and dig up figures which they can submit to a manufacturer and show him how enormously expensive his plant is and how much more it is costing him than it would cost if they were allowed to furnish power.

In Mr. Hibner's paper the statement is made that "Sometimes manufacturers retain consulting engineers on the basis of a percentage of the cost of the plant if it is installed. The dangers of such a practice are quite evident, as it is asking a good deal of human nature for a man to lose a neat commission on the sale of a plant by recommending the purchase of power." Yet Mr. Hibner would not hesitate to recommend this manufacturer to go to the sales agent or industrial engineer of a power company for the same information. Is not this latter method a far more dangerous practice? The consulting engineer does a large amount of work for his money. He not only determines whether or not it is advisable to install a plant, but if to his satisfaction and to the satisfaction of his client he has proved that it is advisable, he lays out the plant, supervises its installation and sees that it meets the requirements of the manufacturer. Does the sales agent of the power company do anything in this line?

The figures given by Mr. Hibner would not lead one to believe that his figures are as convincing or as nearly correct as would be likely if the figures were submitted by an engineer who was not biased in either direction, and no good engineer would be biased any more than would a good doctor. A man with a broken leg would not go to a carpenter because the carpenter has all of the tools necessary and knows how to saw off the leg or knows how to make the splints. He would go to a surgeon.

The question of whether to purchase power or to generate it, depends entirely upon the relative cost of the two methods. In most cases it is a question not only of power, but also of supplying steam for heating and other purposes in addition to the power, resulting in the plant operating noncondensing with more or less back pressure during the winter months. The steam economy is not as good as would be expected from a condensing plant, but there is no reason why the steam consumption should be excessive or an uneconomical type of engine purchased.

Taking up the specific points of the discussion, Mr. Hibner considers a shoe factory of approximately 250x60 feet general dimensions, four stories high and built of brick. In the portion of the country selected, that of Toronto, heat is required for approximately seven months in the year; and, according to his figures, an average of 45 boiler horsepower is required, with 90 horsepower during zero weather and probably considerably over this during exceedingly cold weather. According to Table 1, the coal required for heating alone is 475 tons.

TABLE 1

HEATING PLANT INVESTMENT

Boiler, piping and auxiliaries (*A*)	$1500.00	
Building and stack (*B*)	2500.00	
Total investment	$4000.00	
FIXED COST		
Interest at 6 per cent. on $4000	240.00	
Insurance and taxes, 2 per cent on $4000	80.00	
Amortization on *A*, 4½ per cent., 15-year life	67.50	
Amortization on *B*, ½ per cent., 50-year life	12.50	$400.00
OPERATING COST		
Coal, 475 tons at $3	1425.00	
Fireman at $15 per week	780.00	
Supplies and repairs	100.00	2305.00
Total cost		$2705.00

TABLE 2

COMPLETE POWER PLANT INVESTMENT

Capacity, 100 kilowatts

Engine, generator, switchboard, wiring (A)	$5,500.00	
Boilers, steam piping, auxiliaries (B)	5,000.00	
Building, foundations, stack (C)	5,000.00	$15,500.00
Steam-heating plant		4,000.00
Additional for power		$11,500.00
FIXED COST OF POWER PLANT		
Interest, 6 per cent. on $15,500	$930.00	
Profit, 5 per cent. on $11,500	575.00	
Insurance and taxes, 2 per cent. on $15,500	310.00	
Amortization on (A) 2 per cent. (20-year life)	165.00	
Amortization on (B) 4½ per cent. (15-year life)	225.00	
Amortization on (C) ½ per cent. (50-year life)	25.00	
Fixed charge on heating plant		$2,230.00
		400.00
Additional for power		$1,830.00
OPERATING COST OF POWER PLANT		
240,000 Kilowatt-hours		
Coal at 7.39 pounds per kilowatt-hour, 887 tons at $3	$2,661.00	
Banking, 181 tons at $3	543.00	
Night heating, 202 tons at $3	606.00	
Engineer at $18 per week	936.00	
Fireman at $15 per week	780.00	
Water	100.00	
Oil, waste, supplies	150.00	
Repairs	200.00	
		$5,976.00
Operating cost of heating plant		2,305.00
Additional for power		$3,671.00
Total additional for power		5,501.00
Cost per kilowatt-hour		0.0229
Cost per horsepower-year		51.40

In Table 2, however, it will be noted that 202 tons are allowed for night heating, leaving a total of 273 tons for day heating. If it requires 202 tons of coal for heating a plant which is entirely closed, as a plant is at night, and where no changes of air take place other than leakage, it certainly would take more than 275 tons of coal to accomplish the same results where there is at least one change of air per hour as well as open windows, doors, etc. It would be better to figure 475 tons of coal for day heating and 202 tons of coal for night heating, making a total of 677 tons of coal for heating during the year. Therefore, it will be noted that in estimating the cost of heating alone, Mr. Hibner has neglected the heating during the night, which he has been very careful to consider in estimating the heating in connection with the complete power-plant equipment. In Table 1, the investment and fixed costs may be left as they are, but the operating cost will increase in the ratio of 677 to 475 on the coal, making a considerable difference in the operating cost of the heating plant. Table 1-A would represent the revised figures.

TABLE 1-A

First Cost and Fixed Charges Same as 1

OPERATING COST	
Coal, 677 tons at $3	$2031.00
Fireman at $15 per week	780.00
Supplies and repairs	100.00
	$2911.00
	400.00
Total operating and fixed charges	$3311.00

There might also be added to this operating cost, according to his own paper, the cost of the coal required to generate the steam which is required at high pressure during the entire year, for which no allowance has been made, although the time of the fireman has been figured for this period. Besides, it is advisable to note that since steam at a high pres- is required for industrial purposes, ..e boiler plant, piping, etc., must be purchased for high-pressure service.

Now consider what it will actually cost to install and furnish power from a power plant.

TABLE 2-A

100-kilowatt generator and engine	$4,000.00
Boiler, piping and auxiliaries	2,500.00
Buildings, stack and foundations	4,500.00
	$11,000.00
Steam heating plant	4,000.00
Additional for power	$7,000.00
Fixed Charges	
Interest, 6 per cent. on $11,000	$660.00
Insurance and taxes at 2 per cent	220.00
Amortization, 3 per cent. on total	330.00
Profit (to help out Mr. Hibner)	350.00
Fixed charge on heating plant	400.00
Additional for power	$1,160.00
Total fixed charges	$1,560.00
Operating Charges	
Coal, 6 pounds per kilowatt-hour, 720 tons at $3	$2,160.00
Night heating, 150 tons, at $3	450.00
Engineer at $20 per week	1,040.00
Fireman at $15 per week	780.00
Oil, waste, water, repairs, supplies	450.00
	$5,880.00
Operating charges for heating	3,310.00
Additional for power	$2,570.00
Total for power, fixed charges	1,160.00
	$3,730.00

Table 2-A gives the first cost, fixed charges and operating charges according to my estimate. There certainly seems to be no reason why a 100-kilowatt plant using noncondensing engines and apparatus moderate in price, should cost over $110 per kilowatt; and, although these figures may appear small to Mr. Hibner, I have recently installed a 200-kilowatt plant at very nearly these relative figures, as well as a number of 100-kilowatt plants.

The profit item shown in these tables requires explanation. If the profit is to be considered at all, it should be considered on everything that a manufacturer owns; and if taken in this light, very few manufacturers would own anything; they would prefer to rent everything. Therefore, it would seem that this item should not be taken into account in the fixed charges on the plant. I should prefer to use this item as an item of profit in favor of utilizing my own plant, and not as a charge against my plant, using it to pay off in a greater or less time the total cost of the installation, thus making the installation entirely a profit from an operating standpoint. Therefore, I should deduct this 5 per cent. from Table 2-A and make the fixed charges $1210 instead of $1560, making the additional charge for power $810 instead of $1160. This would make the total fixed and operating charge for power additional over what is required for heating, $3380 instead of $3730, or 1.41 cents per kilowatt-hour.

An explanation may be necessary for the reduction of coal from 7.39 to 6 pounds per kilowatt-hour. While an evaporation of 7 pounds is not bad for a heating plant, it is probable that a power plant which is in continuous operation would do better than 7 pounds; hence, an evaporation of 8½ or 9 pounds is not excessive. It would have been better had Mr. Hibner given some idea as to the quality of the coal, as good coal would probably do better than 7 pounds and poor coal might do much worse.

I have under observation three plants requiring a maximum of 140 horsepower and an average of about 110, all operated by Corliss engines which, in spite of their age, something over 15 years, are in good condition. These plants operate noncondensing with a back pressure during the winter months of approximately 2 pounds. The buildings are of wood and heat is kept on all night during the winter, yet the coal bills are something less than $2400 for the year. in spite of the fact that the coal costs $4.50 a ton instead of $3, as given by Mr. Hibner. It might be well to add, however, that there is more or less leather burned in all of these plants, and the same would be true in the factory under discussion by Mr. Hibner, unless he has some means of disposing of this leather more profitably, which is doubtful.

It is hard to account for the necessity of the 181 tons of coal which Mr. Hibner has assumed for banking purposes. For about seven months of the year there is night heating, for which he has allowed 202 tons of coal. During the other five months of the year he would not require over 300 pounds of coal a night for banking purposes, should it be found advisable to bank the fires, which is by no means true in all cases, for the plants referred to find it is cheaper to allow the fires to go out each night. Mr. Hibner figures 1.45 tons of coal per night for banking purposes. I would like to ask how he succeeded in getting this coal upon the grate; and further add that a good-sized plant can readily be operated on 1.45 tons of coal per day.

Such figuring as this would lead one to believe that it is far safer to trust to the consulting engineer for figures, even although he be paid upon the percentage basis, than upon the figures of the sales engineer of a central power plant, for it is apparent that the latter does not take average conditions but extreme cases. The consulting engineer, however, figures on a conservative basis from plant tests and results obtained in actual practice on good plants.

The great difficulty most manufacturers have in taking up the matter with the central-station man is in getting fair figures. Everything is given an artificial value, in order to make the power cost as high as possible; and, as Mr. Hibner states, when the manufacturer is not an engineer, he has great difficulty in determining where the central-station man is at fault, or in translating the contract of the central-station man so that it means anything to him. It is true that the load factor has an important bearing upon the cost of power, not only as generated by the manufacturing plant, but also when purchased from the central station. Very few power-company contracts give a flat rate regardless of the load factor, and most of them are on a sliding-scale basis, so arranged that the cost of power as purchased increases far more rapidly as the load factor decreases than would the cost of power if generated. Particularly is this true when there is a fixed charge per horsepower of motors installed, and other methods of charging which call for a fixed monthly rate regardless of the power used.

The consulting engineer is by no means adverse to so laying out a plant that it can be operated by purchased power for a sufficient length of time to prove to the manufacturer that his estimate of power cost under conditions of purchased power is correct, and at the same time so arrange the plant that a power installation can be later installed, if necessary. This arrangement gives the central station a fair chance, and by a proper arrangement of the buildings it will enable the new power installation to be installed with no excess cost over what would have occurred had it been installed at the same time the plant was laid out for purchased power.

Emergency service is more a theoretical necessity than a practical one. The central-station man claims that such service is absolutely necessary. A study of the conditions existing throughout the industrial world would hardly bear out this opinion, as for years the majority of manufacturing plants have been operated from a single unit, some of them operating 24 hours a day for six days out of the week, with hardly a shutdown in the entire life of the plant. A good reliable engine and boiler plant, well installed, is more free from the possibility of breakdown than is power from any central station. There are hundreds of factory plants which operate six days out of the week without a breakdown or shutdown, year in and year out; but I do not believe there is a single central station in the country that has not had power off its lines for a greater or less period of time at least once a year, ever since it was installed, and I know of a number of plants that have been off from three to five such times, varying in length from 15 minutes to 3 hours, in the last few years. In one case, that of a large central plant, power was off nearly all day, and in every case the transmission lines were short and most of the trouble was with the lines. There was also trouble in the plants themselves.

Central-station service is, as a rule, good, but as regards reliability and continuous service, it is not to be compared to that of the individual power plant if the apparatus purchased is good and properly installed.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

An Endurance Test of Aeroplane Engines

An official 24-hour test of aëroplane gasolene engines was made recently by the National Physical Laboratory, which is under the control of the British government, though not relying entirely upon government support. All the research work of the official advisory committee of aëronautics is carried out at this place, where a very fine testing plant is gradually being amassed. Originally six builders entered the competition, but only three actually presented their motors for test. Two of these failed in the endurance test, leaving a single competitor to complete the full schedule of the trials.

To prove the trustworthiness of the engines it was stipulated that they should make a run of 24 hours at full load with not more than three stoppages nor a total duration of stoppages exceeding 30 minutes. While the engine was running the only adjustments permitted were those that could be made by the levers for ignition and carbureter control. Handling of the engine for any other purpose was forbidden. Oiling by hand, for instance, was not permitted.

An additional test had to be undergone to determine whether the motor would work satisfactorily when tilted about an axis transverse to the shaft. Two runs of one hour each were made at an angle of 15 degrees, first one end and then the other being elevated.

The motors had to be designed to give 35 brake horsepower and not to weigh more than 245 pounds; that is, 7 pounds per brake horsepower. The weight, however, included not only parts necessary for ordinary running, but also the cooling apparatus with its accessories, such as fans, etc. Neither gasolene, water nor oil was reckoned as motor weight, nor was the gasolene tank.

Among the most interesting and practical conditions were those relating to the air current and the propeller thrust. The test was made without propellers, but to represent the thrust an artificial load of 175 pounds was applied to the thrust bearing. To represent aërial conditions the tests were made in an artificial air current of 30 miles an hour delivered from a horizontal pipe six feet in front of the motor and 4x4 feet in cross-section.

In order that no possible bias may be allowed to enter into the description of the engine trials, the results are given herewith as they appear in the official report just issued (Government Booklet Cd. 5453).

Wolseley Engine: After a preliminary run the test was commenced at 1:11 p.m. on September 12. The engine ran very smoothly, doing 36 brake horsepower at 1443 revolutions per minute for two hours. It was then discovered that a copper oil pipe leading from the pump to the oilwell was leaking. The maker's representative decided not to stop, and, after 20 minutes, disconnected and blanked off this pipe while running. It appears, however, that this change interfered with the oil supply to the bearings, for the engine commenced to run irregularly and finally stopped at 4:13, when it was found that the white metal of one of the connecting-rod bearings had melted. In accordance with the regulations, the engine was therefore disqualified.

The representative of the maker, however, expressed the desire to repair the engine that it might again undergo a 24-hour trial. In view of the nature of the failure and the value of having as complete a test as possible of the engine, it was considered desirable to accede to this request. A new bearing was accordingly fitted and another trial was started at 9:50 a.m. on September 15. The engine ran very well for four hours and then began to run irregularly. After five hours of the test a stop was made and a new spark plug was fitted to one cylinder. This was repeated after another hour's run but without improving matters, the trouble being apparently due to faulty action of the radiator.

After six hours of the test there was a stop for 50 minutes. The radiator was emptied and refilled. After restarting, the engine ran for six hours and then failed. After three more short runs, of

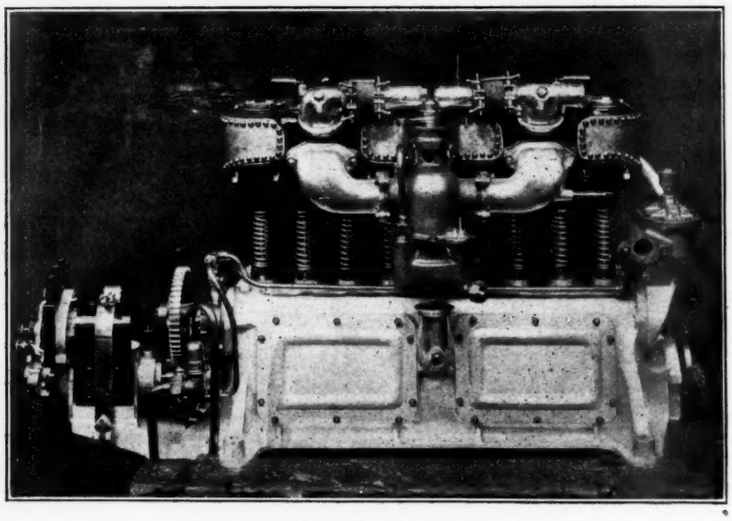


FIG. 1. THE WOLSELEY ENGINE

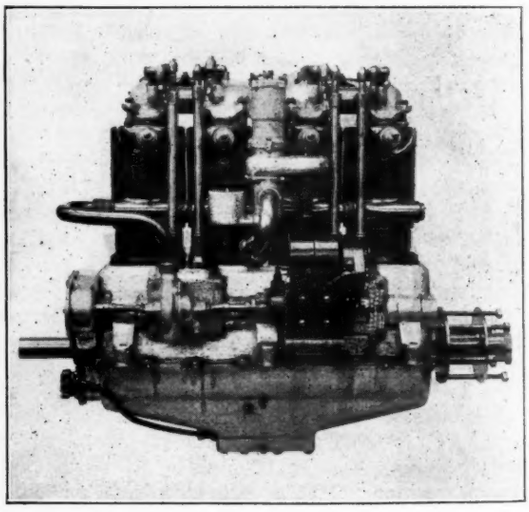


FIG. 2. THE HUMBER ENGINE

23 minutes, 92 minutes and 38 minutes, respectively, it was observed that the cooling water was rapidly disappearing. The engineer in charge then decided to stop and examine the cylinders. On applying water at about five pounds pressure to the jackets, it was found that the water was making its way into all four cylinders through cracks in their upper ends. The test was therefore discontinued after a total run of 17 hours and 41 minutes, including seven stops aggregating 2 hours and 18 minutes. The cylinders were taken to the works the next day, September 16, and on September 17 the Wolseley company withdrew from the competition.

Humber Engine: The erection of this engine was commenced on September 19 and a preliminary run was made on September 21. On September 22 the maker's representative asked for permission to install another radiator, as the one sent with the engine was inadequate. He was informed that the committee might take a serious view of such an alteration and that the company must make any alteration on its own responsibility. On September 23 another radiator was put on and, after a preliminary trial, the endurance test was commenced on September 26, at 9:45 a.m.

After running for 16 minutes, as the ignition in one cylinder was not satisfactory, a stop of two minutes was made and a new spark plug put on. The engine then ran steadily, doing 37 brake horsepower at 1224 revolutions per minute for 11¼ hours, when the engine suddenly failed; on inspection it was found to be completely wrecked, with one of the cylinders broken off. The only attention to the engine during this period was the addition of 12½ pints of oil seven hours after the commencement of the trial and 50 pints an hour later. On the following day the engine was examined more in detail, and it was found that, in addition to the fractured cylinder, two connecting rods were buckled and the big end caps torn off, several holes were made in the crank casing and the crank shaft was damaged. This accident, of course, brought the test of the Humber engine to a conclusion.

Green Engine: A preliminary run of the engine was made on October 17 and the endurance test was commenced at 10:30 a.m. on October 18. The engine did not run very satisfactorily during the first hour, owing to difficulties with the ignition, and after one hour's run a stop of ten minutes was made, during which new spark plugs were fitted. On restarting, the engine ran much better and continued running at approximately 31.5 brake horsepower at 1213 revolutions per minute, until the completion of the 24 hours' run on October 19. The only attention to the engine during this period was the addition of 42 pints of oil 17 hours after the commencement of the trial and an additional 21 pints five hours later.

The maximum horsepower which could be maintained for seven minutes was determined on the same day without any overhauling of the engine, except grinding in the valves. The horsepower obtained was 36.4 at 1390 revolutions per minute.

To determine whether the engine would work satisfactorily when tilted about an axis transverse to the shaft, two runs of an hour each were made on the engine when tilted at an angle of 15 degrees, first one end and then the other being elevated. The makers did not wish to run the engine at full load during this test and maintained the load at approximately 18 brake horsepower throughout both trials. The engine ran steadily in both cases, but it was noticed that the exhaust was decidly smoky, apparently indicating overlubrication.

The general steadiness and freedom from vibration of the engine when running were so marked that it was not considered necessary to test it when running on elastic supports.

On the completion of the trials the engine was dismantled and the working parts thoroughly examined. Very little wear could be detected in the crank-shaft and connecting-rod bearings and the state of the cylinders and valves appeared to be quite satisfactory. The ball races of the thrust bearing at the propeller end of the crank shaft were, however, considerably worn. In the crank-shaft bearings one of the aluminum caps was cracked right through for about one-third of its length. It was not certain that this crack had originated during the tests, as there was some evidence that it existed before these trials began, but it appeared probable that the crack became larger during the tests. It was found that the sleeve inside the small end of one of the connecting rods had rotated so that the oil way to the pin was blocked up; also, that the gudgeon pin had shifted sidewise and had been rubbing against the side of the cylinder.

The Engines

A beautiful piece of work indeed was the Wolseley engine. It had, of course, been especially designed for aëroplane work, but the main consideration kept in mind has been not the reduction of weight, but the production of a reliable motor. The engine which was entered for the contest had four cylinders of 3¼-inch bore by 5½-inch stroke and was rated at 30 brake horsepower at 1100 revolutions per minute or 37 brake horsepower at 1400 revolutions per minute. The weight was 205 pounds complete with magneto, carbureter and all piping, but no flywheel. The cylinders are cast in pairs with each head and liner in one piece. All the valves are on the same side of the motor and operated by hardened-steel tappets, as shown in Fig. 1. A special feature is the use of four water jackets of planished sheet metal.

In appearance, the Humber engine is strongly reminiscent of a motor-car engine, the copper water jackets being the only apparent feature of difference. The cylinders are of cast iron, machined all over, with a bore of 4.33 inches and a stroke of 4.725 inches. Both the inlet and the exhaust valves are overhead and operated by concentric push rods from a single cam shaft in the upper half of the crank case. The outer push rod carries at its upper end a light bracket, by means of which the rocker arm for the inlet valve is moved. The carbureter is of the single-jet type with an automatic auxiliary air valve seated by the usual adjustable spring. The crank shaft is hollow and supported by ball bearings of large diameter; one bearing is provided between every adjacent pair of cranks. The connecting rods are of chrome-nickel steel of very light section, and the pistons are turned from solid-bar steel. Forced lubrication is provided through the hollow crank shaft to the big-end bearings of the

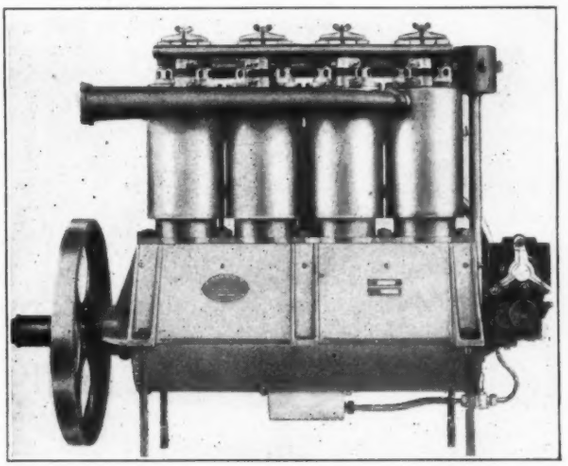


Fig. 3 The Green Engine

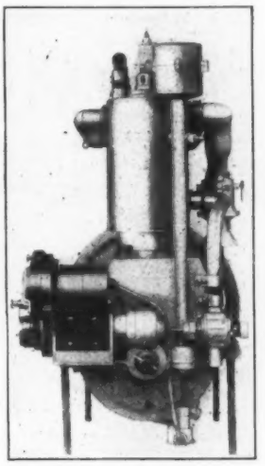


Fig. 4

connecting rods; the oil pump is of the gear-wheel type. Complete with its piping and magneto the weight of this engine is 232 pounds, and 42 horsepower is developed at 1200 revolutions per minute; the weight per horsepower is, therefore, 5.5 pounds.

It is an odd fact that the Green engine, which made the best showing in the contest, was designed and built before the recent developments in aëroplanes. It was

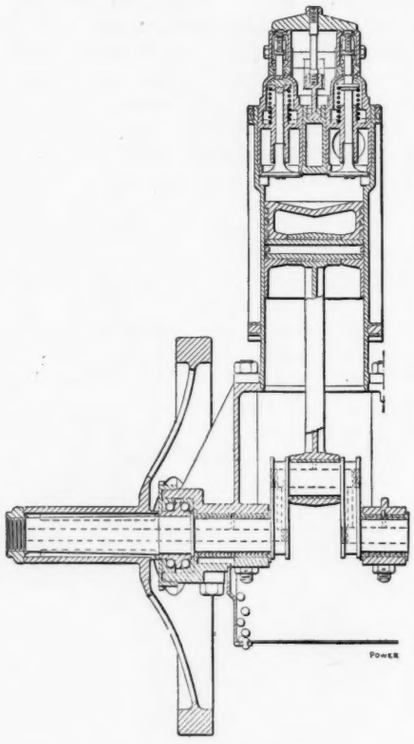


FIG. 5. A GREEN CYLINDER

shown at a small exhibition as long ago as 1905, but at that date was, of course, regarded as a freak. It does not come within the category of extra light engines. The contest model, which develops 32 horsepower at 1220 revolutions per minute, weighs 181 pounds with all pipes, connections, carbureter and flywheel, but excluding ignition apparatus; that is almost 5.7 pounds per brake horsepower.

Unlike the majority of aëroplane engines, the Green motor is practically of orthodox automobile design, the weight being reduced by the judicious choice of material and not by ingenuity in the arrangement of the working parts. Each cylinder, with its head, is cast in one piece of steel and is machined inside and outside. The water jacket is made of thin polished copper and the greatest body of water is distributed unobstructed around the valves and the head. The cylinders are offset with respect to the crank shaft and the latter is provided with five bearings. The lower part of the crank case is made of sheet aluminum and makes a tongue-and-groove joint with the upper part of the crank case, which is a casting.

The crank shaft is made hollow for the sake of lightness; for the same reason the crank cheeks are grooved in an unusual manner (see Fig. 5). One end of the crank shaft receives the propeller and from the other end the pump and magneto are driven through spiral gears. A vertical shaft inclosed in an aluminum oil-tight case takes the drive to the overhead cam shaft and down to the oil pump, as indicated in Fig. 4. The cam shaft is driven through bevel gears and runs in four bearings in an oil-tight case; each cam with its rocker arm is also completely enclosed. The valves are in removable cages and are prevented from falling into the cylinder by ledges below the valve seat, as may be seen in the accompanying section of one of the cylinders, Fig. 5.

One of the most interesting features of the engine is the floatless carbureter, designed to work equally well at all angles. The supply of gasolene and air is controlled by the engine suction. Fig. 6 is a sectional elevation of the carbureter. There is a small clearance between the head of the choke cone *D* and the head of the gasolene valve *Y*. This permits a tight joint between the gasolene

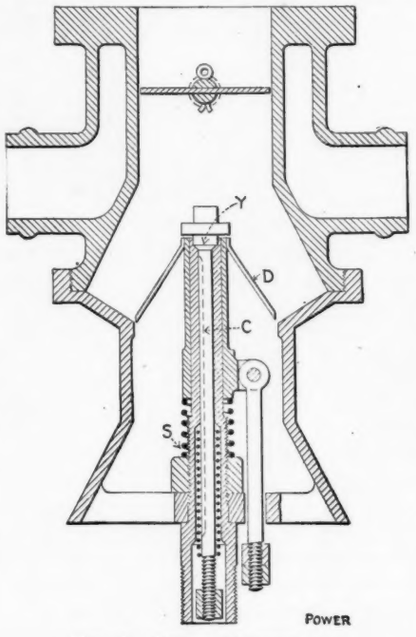


FIG. 6. GREEN CARBURETER

valve and the end of its casing when the valve is down. As soon as suction takes place the choke cone, after taking up the clearance, commences to lift the gasolene valve from its seat, the force of the suction determining the extent of the lift. The gasolene is fed through the milled channel *C* in the side of the valve stem; this channel diminishes toward the seat of the valve and therefore passes more gasolene at high suction than at low, but beyond a certain point there is no increase in the opening. The spring *S* acts in the capacity of a flexible stop for the choke-cone sleeve when it drops.

Engineers for Gas Engines

BY M. W. UTZ

Mr. Hamilton's article on this subject in the April 25 issue was especially interesting to me, possibly because I happen to be familiar with a typical case of the no-engineer fallacy. A small manufacturing establishment was formerly equipped with a 65-horsepower slide-valve steam engine supplied from an 85-horsepower tubular boiler, the excess boiler capacity being used for steaming raw material before manufacturing. This plant was not very economical in operation, so when a gas-engine salesman began to quote figures on the cost of installing and operating a gas engine, the owners were all attention, especially as to the claims made by the salesman that "the labor cost would be practically nothing, because they would not need an engineer; an ordinary laborer could fill the oil cups and start the engine in a few minutes, and this was all that would be necessary till time to shut down again." The salesman was also rash enough to promise that the exhaust of the gas engine would evaporate enough water to steam the raw material.

The steam plant was taken out and the gas engine installed in its place and when everything was ready for operation the steam engineer was discharged and one of the owners undertook to look after the gas engine and do the office work. A man from the builder's shop started the engine, which seemed to run very satisfactorily, but the exhaust would not evaporate enough water for their requirements, so they had to buy and install a 10-horsepower boiler. After a short time trouble began, and finally the engine could not be started at all, the compressed air going straight through. A man sent by the builder promptly found the exhaust valve stuck open. Later on, the cooling water stopped circulating and the engine got hot, of course. When the water was turned on again the cylinder cracked; that meant a new cylinder. When cold weather set in, the jacket of the small engine which drives the air compressor was not drained, so it froze up and burst; the rotary pump which supplied the jacket cooling water did likewise. At another time, after putting in a new exhaust valve, the engine failed to give the required power and when a man from the factory was called to see what was wrong, all he did was to grind in the exhaust valve, which they had put in without grinding. So it kept on, a man from the shop being called on to adjust or correct some small matter which a good engineer would have handled without difficulty and saved his salary in doing it.

The service became so uncertain that the central station was appealed to and motors were installed to drive the most important machinery; the arrangement is

such that when the engine balks the motors can drive these machines only, leaving the rest of the plant idle until the engine can be started again. It looks as if the central station will soon be running the entire plant.

Now, this engine is of a well known make and would give good service if properly taken care of as it could be by a capable engineer. The man who attends to it now, or tries to, is inexperienced and is the fourth one in about a year. He has so many other duties to perform that if anything goes wrong with the engine it is generally shut down before he can get to it.

If this firm had kept the old steam engineer, who was a practical man and would have no doubt made a good gas engineer, and not burdened him with so many other duties that he could not have given the engine proper attention, it would have doubtless been a success and the central station would not be supplying motors there today.

In most cases, the steam engineer makes a success with the gas engine, having the advantage over the common laborer of a general knowledge of machinery and experience gained in the engine room of his steam plant.

Over 75 per cent. of the successful gas engineers that I have met were formerly steam engineers, and enthusiastic ones at that, which, I think, leaves little doubt as to who will be the coming gas engineer.

Gas Engineering in the Oil Fields

By H. H. Daniel

About the time when the gas engine was being introduced in the oilfields of Pennsylvania for pumping purposes, we were called upon to make repairs on all sorts of engines, and some of the experiences we encountered were comical; others were far from entertaining. A complaint came in to our shop once to the effect that a two-stroke engine which had been recently installed did not work satisfactorily. When I arrived at the engine house, a couple of pumpers from neighboring wells were on the job and had built a nice hot wood fire under the cylinder of the engine " to warm her up so she would start." We dispensed with the warming-up expedient and after a brief investigation found that the spring on the automatic inlet valve had been screwed up so tight that it was necessary for one of the men to relieve the tension by pressing on the valve stem with a lever in order to get the engine started.

The tension of the spring was relaxed to the proper point but it was found that the gas pressure was too low to furnish the engine with the necessary amount of fuel to carry the load, so we advised the pumper to look over the line for leaks. Following the line, he arrived at an abandoned shanty which stood between the engine house and the wells and, as the room was rather dark, he struck a match. Three very noticeable events occurred at exactly the same time: a loud report, an elevation of the roof of the shanty about six feet above the walls and the projection of a dark object through the door of the shanty. Upon examination we found that the dark object was the pumper, not hurt much but badly scorched and more badly scared. We went into the shanty (without a light) and found that the side outlet of a ¾-inch tee was open and out of this the gas was freely flowing. A stove had been used in the shanty and when it was removed, the detail of plugging the tee had been ignored. After we plugged it the engine was started and ran very nicely.

An Ingenious Crank Pin Oiler

The accompanying engravings illustrate the method finally adopted for delivering oil to the crank pin of a Lammert & Mann 8x10-inch gas engine after trying about everything else that could be found.

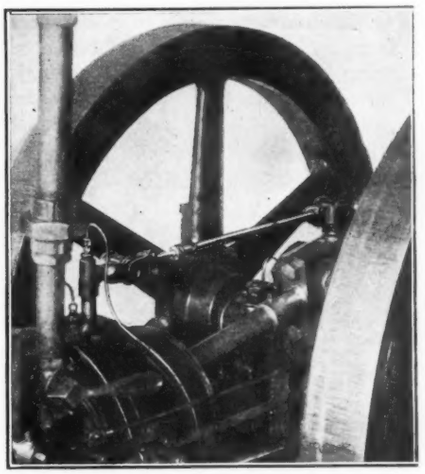


Fig. 1. Crank-pin Oiler

The arrangement consists merely of a pair of telescopic tubes attached at one end to a Nugent swivel joint on the crank end of the connecting rod and at the other end to a similar fitting mounted on the cylinder housing. A stuffing box is provided on the end of the large tube where the smaller one enters it but no packing is used on the swivels; the joint between the fixed and oscillating members is closed by a beveled metal-to-metal nose and seat held in contact by a flat spring. This construction is more clearly shown in Fig. 2. Oil is delivered to the stationary end of the arrangement by a force-feed pump.

The speed of the engine is 300 revolutions per minute and we are informed that this made it impracticable to use a wiper cup; most of the oil was distributed impartially over everything within range except the crank pin. The application of the telescopic feeder here illustrated is said to have effected an amazing reduction in oil consumption and to keep the crank pin thoroughly lubricated. It was made by W. W. Nugent & Co., Chicago.

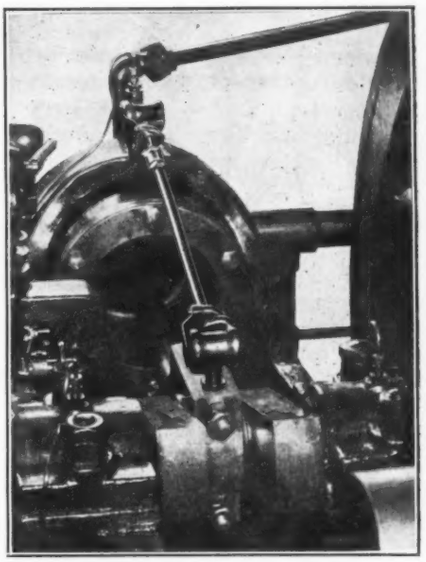


Fig. 2. Crank-pin Oiler

LETTERS

Wanted: Suggestions for Distilling Water

The plant under my charge includes a suction gas-producer equipment of two 100-horsepower units and three 100-horsepower engines driving dynamos which are used to charge storage batteries. The proposition has been put to me to find out whether or not I can make distilled water with the apparatus now in use. Can some other reader of Power suggest a practical method of doing this?

August A. Specht.

Washington, D. C.

[Whether there is sufficient exhaust heat to distil all the water required depends, of course, upon the work done by the engines, the efficiency of the still and the quantity of water to be distilled per day or week. Suggestions from other readers as to the quantity of water that can be distilled with exhaust heat per brake horsepower-hour of engine work will be welcome.—Editor.]

We are reliably informed that Diesel engines are being built by the Krupp works, in Germany, and by Schneider & Co., of Creusot, France, which develop as high as 1800 horsepower per cylinder. Multicylinder engines of about 10,000 horsepower are under construction for the equipment of war vessels.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Changing Generators from Compound to Shunt Wound

By H. R. Mason

In a large power plant in the West which supplied a three-wire system at 120 + 120 volts through a number of shunt-wound rotary converters of a combined capacity of about 1500 kilowatts, the peak load increased recently until it required the full capacity of the converters and left no reserve to be used in case of trouble.

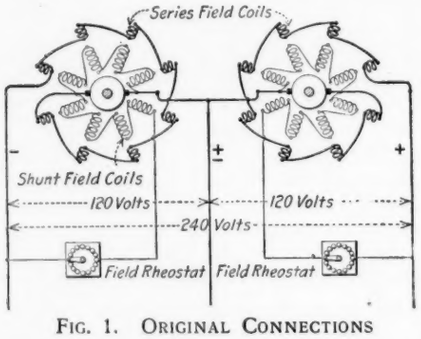


Fig. 1. Original Connections

Before the converters were installed, the system had been supplied by engine-driven compound-wound dynamos and one of the units was left in the station, but it was found impossible to operate this unit in parallel with the rotary converters; it would either pick up load until it was dangerously overloaded or else drop all of its load, when it would reverse its polarity and knock out the entire system. The unit consisted of a 14x24-inch twin Corliss engine direct connected to two 200-kilowatt, 120-volt direct-current dynamos mounted on a common shaft. A diagram of the electrical connections as originally installed is shown in Fig. 1.

In an attempt to make use of the twin unit, the series field windings were disconnected and a load put on the generators, using the shunt field windings only, but it was found that the field had insufficient strength to maintain the voltage with more than one-quarter load. It was found impossible to operate the unit at a high enough speed to produce the necessary voltage, so in its present condition it was of no practical use. As it became imperative that it be put into operating condition, the construction of the dynamos was investigated with a view to making changes in them. The shunt windings were found to contain 370 turns of No. 6 wire on each of the eight poles and passed a current of 40 amperes at 120 volts when all of the field resistor was cut out, making 14,800 ampere-turns on each magnet core. The expedient of connecting the shunt winding of each of the dynamos across the outside wires of the system, at 240 volts, with additional resistance in series, was tried, but it was found that the increased current necessary to maintain the desired voltage overheated the coils excessively.

The series windings had four turns each and carried 1600 amperes at normal load, making 6400 ampere-turns on each magnet core in addition to the 14,800

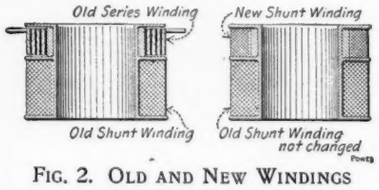


Fig. 2. Old and New Windings

furnished by the shunt coil adjoining it. Upon measuring the space occupied by each coil of the series winding, it was found that additional shunt coils could be substituted for the series coils (see Fig. 2), each containing 370 turns of No. 8 wire. It was calculated that each coil would contain 1480 feet, making 11,840 feet on each of the 8-pole field magnets, and the wire table indicated that about 20 amperes would flow through that length of No. 8 wire at 120 volts, allowing for the same temperature rise as in the old coils. This would afford 7400 ampere-turns per pole to take the place of the 6400 formerly supplied by the series fields and would accomplish the double advantage of enabling full voltage to be maintained at all loads and reducing the speed somewhat.

Accordingly, all of the series coils were removed and additional shunt coils substituted, connected in parallel with the old shunt winding, as shown in Fig. 3. As the total field current was increased from 40 amperes in the original winding to 60 in the two, the field rheostat had to be remodeled and this was done by using standard street-railway motor resistor grids connected to the old face-plates. Of course, care was observed to connect the extra shunt field winding in such a manner that the current through it flowed in the same direction as in the old one. When the unit was started it fulfilled all expectations; it could be caused to carry as much as 30 per cent. overload at the maximum required voltage and one further experiment was tried upon it.

Occasional interruptions of the three-wire service were caused by short-circuits or by converters flashing and it was thought that the service could be resumed with less delay if this unit could be caused to take up the entire load upon starting, avoiding the delay necessary to restart and synchronize the rotary converters. The engines were capable of carrying 200 or 300 per cent. of their rated load in an emergency and, as the generators seemed liberally designed, it was thought that the load of 3000 to 3500 amperes would not damage them during the few minutes they would be called upon to carry that load, though 1600 amperes was their normal rating. The 120-volt field windings were again connected across the 240-volt busbars with additional resistance in series, but it was found impossible to maintain the voltage

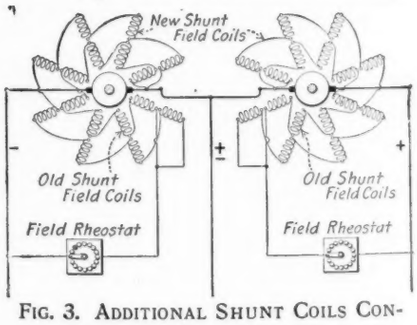


Fig. 3. Additional Shunt Coils Connected in Parallel with Old Winding

with a load of more than about 2500 amperes, or about 60 per cent. overload, as the field-magnet cores were then practieally saturated and further increase of current through the coils had little effect on their magnetism.

The unit has served to prevent several serious interruptions to the service since these changes were made and has been used to improve the station economy by taking part of the load from the rotary converters at times, allowing less efficient units to be shut down earlier.

Regulation of Rotary Converters

By R. A. Cultra

To allow the direct-current voltage of a rotary converter to be altered by adjusting the field rheostat or automatically by field compounding, a reactance coil is usually connected between the low-tension terminals of the transformers and the collector rings of the converter. Without such a reactance the maintenance of the same voltage at full load as at no load entails excessive leading and lagging currents and consequently excessive heating in the converter armature, unless the resistance drop from the source of constant potential is small, or the natural reactance of the circuit is unusually high. If the converter field is weakened a lagging current is set up which causes a voltage drop in the reactance coil. If the field is strengthened a leading current is set up which gives a rise of voltage in the reactance coil. Under a heavy load, the series winding of a compound-wound converter tends to produce leading currents, which tendency is practically balanced by the reactance, improving the power factor of transformers, lines and generators when loaded. The standard reactances are rated in kilovolt-amperes and are usually equal to 15 per cent. of the kilowatt rating of the converter.

The heating of converter armature conductors is greatly increased by the presence of leading or lagging currents. The series field winding of a compound-wound converter considerably increases the excitation at full load over that at no load; for this reason compound-wound converters should be adjusted to take a considerable lagging current at no load, which will be corrected by the action of the series field winding at normal load, thereby giving a good power factor and cool running when loaded.

For interurban railway service with low load factors, the converter should take about one-fourth of the full-load current at no load and this current should be lagging. The character of the current can be determined by the adjustment of the field rheostat. If the weakening of the field by cutting in more of the resistor increases the alternating-current input, the current is lagging; if it diminishes the alternating-current input, the current is leading. If the converter does not give the desired direct-current voltage with the desired setting of the field rheostat, the alternating-current impressed voltage should be altered by adjustment at the power house, if possible; if not, by changing the primary taps of the step-down transformers feeding the converters.

For compound-wound converters with steadier loads having a high average load factor, the lagging alternating current at no load should be greater than 25 per cent. of the rated full-load current; somewhere around 35 to 50 per cent.

The no-load current of a converter should be measured when the equalizer switch is open if other converters are in operation in the same station; otherwise, the current from the other machines will affect the excitation of the machine under investigation.

Rotary converters must not be operated above their rated voltage without proper adjustment of the transformer taps and alternating voltage. Overheating of the armatures is almost certain to occur with compound-wound converters run above normal direct-current voltage if a high average load is carried.

The ratio of the voltages at the alternating- and direct-current brushes of a converter varies slightly in different machines, due to differences in design. The best operating conditions exist when the desired direct-current voltage is obtained with unity power factor at the converter terminals when loaded.

Three-phase and six-phase converters require different voltages from the transformers on account of the difference between the connections of the armature taps. The no-load alternating voltage delivered from the transformers best adapted to compound-wound converters designed to carry variable loads is 61¾ per cent. of the direct-current voltage for a three-phase converter or 71¾ per cent. for a six-phase converter. These ratios give a lagging alternating current at no load, a leading current on overloads and unity power factor at about the average load.

CORRESPONDENCE

Paralleling Two Phase and Three Phase Alternators

In the April 11 issue of Power I noticed an inquiry from D. M. Grove as to the operation of three-phase and two-phase alternators in parallel. I have charge of two power stations, one of which supplies two-phase currents at 2200 volts and the other three-phase currents at 13,200 volts, both at 60 cycles. The generating equipment at station No. 1 consists of two 180-kilowatt machines with closed-coil revolving armatures, similar to those described by Mr. Grove, and with compensating field windings and rectifiers; one 180-kilowatt revolving-field alternator, and one 360-kilowatt revolving-field machine. At station No. 2 there are two 600-kilowatt, three-phase machines with Y-connected armature windings. The transmission line from this station extends 15 miles to a substation which is three miles from station No. 1. Here the two lines are put in parallel through Scott-connected transformers wound for 13,200 to 2200 volts.

These two stations operate in parallel without any trouble and with very little cross current. Of course, it is necessary to adjust the field rheostats very carefully and in the case of the machines having compensating windings the adjustment of the rectifier brushes requires a good deal of care; otherwise cross currents may run up very suddenly and blow the fuses or open the circuit-breakers. The accompanying diagram shows the circuit connections between the machines just described. There is also a 300-kilowatt alternator at the substation which is operated as a rotary condenser (overexcited synchronous motor), and this is a great help in keeping up the power factor.

Where trouble is experienced in operating alternators in parallel it is generally found to be in the speed regulation of the motive power. To avoid "hunting," the governors should not be too sensitive; in some cases it is found necessary to dampen their action by means of dashpots. In the case of slow-speed engines it may be found necessary to increase the flywheel weight in order to absorb the impulse received at each stroke.

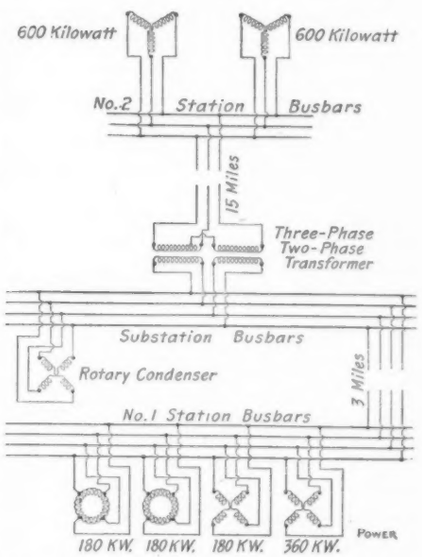


Diagram of Circuit Connections between the Machines of Each Station

Thomas Henry.

West Toronto, Ont.

The *Electrical World* states that the energy from Niagara falls, including operation on both sides of the falls, is used at the rate of 126,000 horsepower for electrochemical process, 56,200 horsepower for railway service, 36,400 horsepower for lighting and 54,540 horsepower for various industrial services, the total being 273,140 horsepower. Since the water of Niagara falls represents probably 5,000,000 horsepower, it would seem that only about 5.5 per cent. of the available power is being utilized at present.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Inspectors Disagree

The conditions that prevail in Massachusetts, whereby old boilers are allowed to be operated so long as they hold their shape and comply with the requirements of the Massachusetts Board of Boiler Rules, are again illustrated in the case of a boiler owned and operated by a manufacturing company in that State.

The boiler is of the vertical tubular type and is described by the inspection certificate hung in the boiler room as follows: "Pressure allowed, 90 pounds; age, 21 years; length, 17 feet 6 inches; diameter of base, 60 inches; diameter of waist, 43 inches; tensile strength, 60,000 pounds; number of tubes, 96; diameter of tubes, 2½ inches; length of tubes, 14 feet; longitudinal joint, double-riveted lap; per cent. of strength of joint, 61 +; location of fusible plug, in tube."

On April 15, a State inspector visited the plant and ordered the boiler out of service until the following repairs had been made: A new ring in the frame of the furnace door; all tubes renewed and beaded; two patches put on, one on each side of the furnace-door frame; and the changing of the steam-gage pipe connection, which was tapped into the shell of the boiler slightly above the ogee seam, to be run from a tee at the top pipe connection of the water column.

The owner, believing that the extent of the repairs ordered by the State inspector was excessive, submitted the boiler as a risk to the steam-boiler insurance company whose inspector inspected the boiler on April 22 and recommended the following repairs to be made before the boiler could be accepted as a risk by the company: Ten tubes renewed; the ring in the furnace-door frame strengthened by fastening a flat piece of iron across the bottom (similar to a dead plate); one patch near the furnace door and the changing of the steam-gage pipe connection as was ordered by the State inspector.

These repairs being completed, the certificate of inspection was issued and so far as the parties directly interested are concerned the incident is closed.

In view of any possible failure that may occur to the boiler it looks as though the State inspector had all the best of the argument, inasmuch as he was endeavoring to give the owner and the public the benefit of the lesson taught by a recent disastrous failure of a boiler of this type. It is regrettable that when two eminently competent inspectors disagree as to the extent of repairs necessary to put a boiler in a safe working condition, that the law should be so worded as to allow the least of the recommendations to be accepted.

A rule that is printed in large type in the instruction book issued to railroad trainmen, "When in doubt, take the safe course," might well be followed by boiler inspectors when determining needed repairs.

JOSEPH KING.

Boston, Mass.

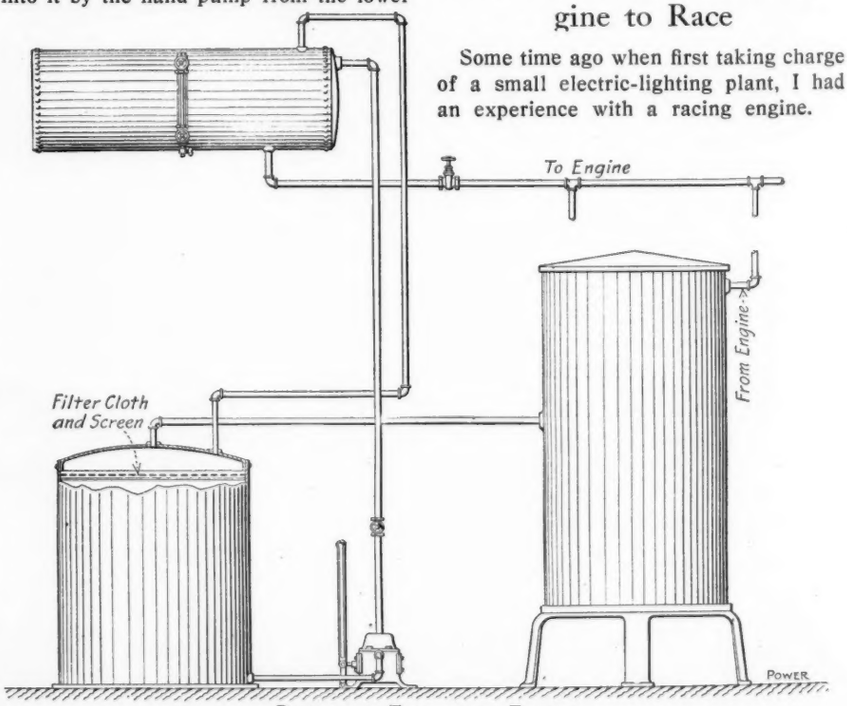
Clogged Overflow Pipe Caused Trouble

The accompanying illustration shows an oiling system that gave trouble. The gage glass on the overhead tank would fill to overflowing when oil was pumped into it by the hand pump from the lower tank. As it was known that there was not enough oil in the system to fill the tank it was concluded that there must be something wrong. In about 15 or 20 minutes the gage glass would be completely empty, although the oil was flowing freely to the engine bearings.

The chief finally investigated and found that the pipe leading from the overhead tank to the lower tank, which serves the double purpose of overflow and air relief, had become stopped up by the oily filter cloth that was on the screen in the lower tank, thus making the overhead tank air tight except for the little vent hole in the cap of the gage glass. As the oil was pumped up in the overhead tank a slight pressure was created which forced the oil up into the gage glass, and made it overflow through the vent hole; then, as the oil flowed to the engine, a partial vacuum was created in the tank, which caused the oil in the gage glass to flow back into the tank, completely emptying the glass. Upon taking down the overflow pipe and shortening it about 3 inches so it would clear the filter cloth, the trouble was cured once and for all.

FREDERICK M. PERRAS.

Mansfield, Mass.



PIPING TO TANK AND FILTER

Loose Setscrew Caused Engine to Race

Some time ago when first taking charge of a small electric-lighting plant, I had an experience with a racing engine.

This plant ran from dusk in the evening until the next morning. During the first few evenings the engine ran nicely; then, one evening there came several sharp pounds from the front end of the engine, and suddenly it began to race. By the time I had reached the throttle the voltage had got so high that the circuit-breaker tripped, leaving the building and town in darkness. This, of course, relieved the engine of all load, which had been gaining speed with every revolution. I thought there was a yard of threads on that throttle-valve stem before I got the valve closed and it seemed an age before the engine began to slow down.

By the time the engine came to a standstill and two-thirds of the population of the town had rushed to the plant, I had found that a setscrew which held a pin in place in the link of the governor had worked loose, allowing the pin to work out of the link. This put the governor out of commission, which allowed the engine to take steam full stroke.

The governor was soon adjusted and the engine started again, but the next morning, after shutting down, the setscrew was found to be loose again. This, I was told, had occurred before, so I hunted up a setscrew a little longer than the old one and put on a lock nut, after which there was no more trouble. However, I never started that engine again without first inspecting the governor, to be sure it was in good working condition.

M. W. Utz.

Minster, O.

Draft Regulation

A 125-horsepower horizontal tubular boiler furnishes steam for a small factory. The fire is burned out at 6 o'clock each night, and the setting on one side and the rear end is exposed to the outdoor temperature. A fire is started in the morning between 4 and 5 o'clock. During the night the leaking damper allowed a draft of cold air through the furnace and tubes which cooled the setting and the boiler. This reduced the steam pressure to about 25 pounds at 4 o'clock.

In order to prevent this cooling effect, a cleaning door in the flue between the smoke box and the damper is opened each night at closing-up time. This has the same effect as the opening of the flue doors, for the boiler and furnace are kept so hot that now there are about 25 pounds more steam pressure in the morning than there was before this method was adopted. There is also a saving in fuel, less expansion strains on the boiler and setting, which means less repairs.

C. C. Harris.

Springfield, Mass.

Feed Water Problem

Here is a problem that recently came to my attention, which may be of interest to readers of Power.

A boiler has two sources of supply of feed water. Each one is ample for the needs of the boiler for the greater part of the year, but for a month or two during hot weather it is necessary to use water from both sources in order to get the required quantity. One supply is from a stream and the other is from a well. When the water from the stream is in use alone, it is found necessary to clean out the boiler every eight weeks. When the water from the well is used alone, the boiler has to be cleaned out every three weeks. The quantity of water to be used from the stream is 1600 gallons in a given time, and the quantity to be used from the well in the same time and mixed with the stream water, is 900 gallons.

The question is, in how many weeks must the boiler be cleaned out while using the combination water, assuming that quantites of sediment, etc., remain the same for both waters and that no new elements occur from such combination?

At first sight this may appear difficult to some, who might let the problem go because they think it can only be solved by algebra. But it is not as difficult as it looks and it may be solved by arithmetic. There are different ways in which it may be solved, two of which are worked out herewith. The first is as follows:

Assuming that the deposit of material in the boiler is a certain measure when cleaning is necessary, then, in one week, when using the water from the stream, the deposit will be ⅛ measure, and when using the well water, it will be ⅓ measure. The length of the run is not given in the question, but there is the proportion of the two waters which is 16:9; hence, a run of any length of time may be taken in order to find the deposit per week, or the rate of deposit. Therefore, suppose that the stream water is used for 16 weeks and that the well water is used for nine weeks, then the deposit in 16 weeks, using stream water, would be

$$16 \times \tfrac{1}{8} = \frac{16}{8} = 2 \textit{ measures}$$

Using the well water for nine weeks would give a deposit of

$$9 \times \tfrac{1}{3} = \frac{9}{3} = 3 \textit{ measures}$$

This makes a total of

$$3 + 2 = 5 \textit{ measures}$$

in 9 and 16, or 25 weeks, or one measure in five weeks. The boiler should therefore be cleaned out once in five weeks when using both waters together.

Perhaps the other solution will appeal to some as being simpler. It is as follows:

Assume that 1600 and 900, or 2500 gallons of water, are required for one week. With the stream water alone, one-eighth of a full measure of deposit will occur in one week, and with the well water alone one-third of a full measure will occur in one week. But when combining the two waters in the proportion of 1600 to 900 gallons, there is for the stream water

$$\tfrac{1}{8} \times \frac{16}{25} = \frac{2}{25}$$

of a full measure in one week, and

$$\tfrac{1}{3} \times \frac{9}{25} = \frac{3}{25}$$

of a full measure in one week.

Then

$$\frac{2}{25} + \frac{3}{25} = \frac{5}{25}$$

of a full measure in one week, when using both waters, as $\frac{5}{25}$ equals ⅕ of a full measure, the full measure will require five times as long, or five weeks.

How many other ways can the problem be solved? It is of some practical value at least.

Charles J. Mason.

Scranton, Penn.

A Soil Pipe Repair Job

There are several large buildings at the institution where I am employed as engineer. We are about 12 miles from any town which can boast of a plumbing shop, so when repairs about these buildings are necessary I make them myself, rather than allow things to get messed up while waiting for a plumber.

One morning the branch pipe of a sewer connection began leaking, due to choking up of the sewer. I took a coil of messenger cable, which was on hand, bent a knock on one end and by this means located the obstruction about 75 feet away from the building, and managed to knock it out with the wire cable.

I had supposed the leak in the branch was due to the cap not fitting into the threads tight enough, but upon examination found the pipe itself to be split for about 3 inches. I cut a sheet-iron disk to fit on the inside of the pipe, drilled a hole through both cap and disk for a ⅜x4½-inch bolt, on which was slipped an iron washer, to stiffen the disk.

All was put in place and the space between the disk and the end of the pipe filled with putty. The cap was then screwed into place with the threaded end of the bolt extending through the hole in the cap. The bolt nut was then put on and tightened.

Only a few minutes were needed to make the repairs and it proved water and gas tight.

C. Joslin.

Columbia Falls, Mont.

Stopping the Engine Off Center

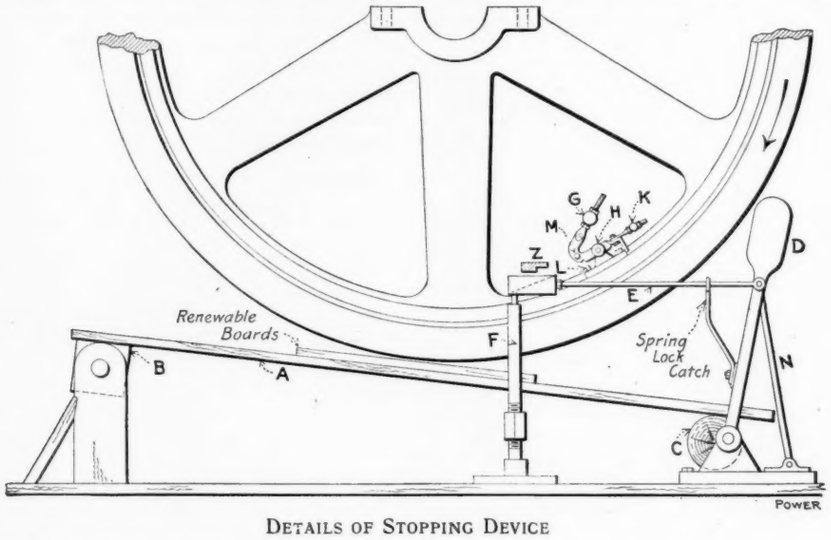
A 24x48-inch single-eccentric Corliss engine, direct connected to a generator, had a habit of stopping on the center, due to a tight piston, leaky steam and throttle valves and lack of judgment on my part. My predecessor had made arrangements with several men in the mill to ring a bell whenever he wanted help to move the crank off the center and, believing the arrangement to have been instituted after other methods had failed, I continued the practice. But no amount of bell ringing would bring anyone to the engine room at shutting down, for the men dashed for home as soon as the whistle blew and would not reappear again until it was time to start up. Thus, about 15 minutes were lost, during which time from 300 to 400 persons were idle.

One day when (from pure cussedness) the engine had stopped with the crank on the center twice in succession, I was called to the manager's office and presented with a slip of paper on which appeared a lot of figures arranged, "*à la* Uncle Pegleg," as follows:

"This mill is operated 300 days in the year; the engine is, therefore, started 600 times and stops 24 times on the center. The average time spent in getting started again in 15 minutes; therefore, the mill is idle from this cause a total of six hours in the year. The pay on the average to 300 operators is 20 cents per hour. Each man then receives $1.20 per year without giving its equivalent in work, a total of $360. This is a net loss. The loss in production is many times this amount. Think this over and see what you can do about it."

Think it over I did, and finally evolved the scheme illustrated herewith. The idea was obtained from watching the showman stopping his swings. *A* represents two 7-inch planks laid side by side and connected by a piece of 4x4-inch joist *B*, through which a 1½-inch pipe passes to the upright posts shown to form a pivot. *C* represents two iron-bound wooden eccentrics, the fulcrum shaft of which passes through the bearings, as shown, and is firmly secured to the upright lever *D*. The club end of the lever is hollow and is filled with shot to form a weight. Its purpose is to cause the planks *A* to bear against the rim of the wheel with a certain tension due to the amount of shot placed in the head. It is supported in place by the reach rod *E*, the head of which latches to the upright *F*.

To the inside of the rim of the wheel is attached the automatic detaching mechanism operated by lack of inertia. It consists of a weight *G*, supported at a certain position on a bent arm pivoted at *H*, and more or less counterbalanced by the small movable weight *K*. The position shown is that assumed when the flywheel is in motion. When it is about to stop, the gravity of the weight *G* overcomes the inertia and the arm drops to rest on the pin *L*. It will be easily understood that the rim of the wheel needs to travel but slowly to cause the weight *G* to fly out. Secured to the bent arm is the pin *M*, the purpose of which is to slide under the head of the rod *E* at the proper time and release the weighted head *D* which manipulates the brake. The latch head of the rod *E* is shown enlarged at *Z*.



DETAILS OF STOPPING DEVICE

The right position on the rim for the releasing governor, with reference to the crank pin, was ascertained only after repeated trials. My method of shutting down the engine is as follows: After closing the throttle, a half-inch valve on a drip pipe leading to the valve chest is opened. Then the brace rod *N* which prevents the brakes from being set when starting up the engine is released. When the engine has slowed down to the speed that is just sufficient to keep the weight of the releasing governor in its outward position, the half-inch valve is closed, and the brake does the rest. The number of stoppages on the dead center was greatly reduced and the device, according to the manager's figures, saves the company $270 yearly.

M. CASSIDY.

South Framingham, Mass.

Screwed Down the Safety Valve Spring

Recently a large fire flue collapsed in a traction-engine boiler of the Scotch type. The engine had been in service for several years and was of 12 horsepower capacity.

The engineer had been running the engine for several years. Three days before the explosion, he took the safety valve apart to clean and after putting it together he believed that he had turned the screw down as many turns as it took to loosen it. At the same time the steam gage was out of order.

When getting up steam on the morning of the accident, the engineer had turned on the blower and when the safety valve popped he started to shut off the blower. Just then the flue collapsed.

An examination showed that the rivet in the flange and lap seam of the flue had given away and ripped most of the rivet heads.

I got the safety valve and tested it under a pressure of 205 pounds before it opened. The engineer supposed he was carrying about 120 pounds pressure.

C. E. RUDY.

Covington, O.

Engine Ran with Broken Crank Pin

In a large cotton mill in one of the Southern States there is a center-crank engine which is used for driving a dynamo that supplies the lights for the mill. It runs at a speed of 175 revolutions per minute. One morning a short time before the engine-room lights were due to be switched off, the oiler noticed them dying out. Looking over at the small engine, he saw that the drivewheel which was belted to the dynamo had stopped, while the other wheel, containing the governor and eccentric, was running along apparently the same as usual.

He shut the engine down, and on examination discovered that the cast-iron crank pin was broken off flush with the face of the disk on the side next to the driving pulley. The other flywheel, which carried the governor and eccentric, had continued running the same as if nothing unusual had happened, being operated as a side-crank engine with only one bearing. The break was almost square across and flush with the face of the disk. The only damage other than the broken pin was a slightly cracked bed between the pillow blocks.

S. KIRLIN.

New York City.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Sulphur for Hot Bearings

In a note on page 639 of the April 25 number, I note that someone recommends sulphur as being good for hot bearings. During a series of bearing-metal tests conducted by the writer, the matter was tried out with results not pleasant under service conditions at least. A bearing was perfectly surfaced, then loaded until the frictional heat developed was about 120 degrees, or about the temperature at which an ordinary operator would commence to get busy. Powdered sulphur mixed with oil was then fed into the box, with the result that the motor was very soon stalled, and when the blue brimstone smoke had cleared away, the condition of the bearing surfaces was the worst I ever saw.

It would seem that the application of a mild abrasive like sulphur is a matter requiring good care and judgment, if a hot box is developed. In such a case, the writer would not attempt to use it without shutting down the machine and starting cold, using the sulphur very cautiously with large quantities of lubricant. I would not use it in any case, unless it was the only thing for the purpose available, on account of its chemical ability to produce tremendous heat, once the boundaries of safety are passed.

A better method, recommended by several erecting engineers of long experience and thoroughly tried out with uniform success in my own experience, is to shave off powder from a cake of sapolio or Bon Ami, whichever is most available, mix it with good oil until a very thin mixture is secured and feed it slowly into the bearing, *after* it has been cooled down, if possible; if not possible to do this at least reduce the speed or pressure, remembering at all times that you are using a mild abrasive; hence while cutting off the high spots you are developing more heat and therefore require more lubrication than usual. This treatment should be applied to bearings one has reason to believe are running warm because of ill fitting or roughness caused by previous overheating.

Sometimes an old bearing will heat because of an accumulation of dirty or gummy oil; in such cases, a liberal application of brine or salt in the oil will cut out an amount of dirt and corruption that will be an eye opener to the novice. Once thoroughly cleaned the bearing will cool down quickly. An application of dilute acid, if available, will often work a similar cure; of course, in all cases, liberal lubrication should be employed.

I should like to read the experiences of others with hot bearings, especially with regard to the use of sulphur. Aside from my own case, I have found men of wide operating and erecting experience very slow to recommend it.

H. B. McDERMID.

Minidoka, Idaho.

Feed Pipe Scaled

In looking through the issue of April 4, I noticed a letter entitled "Feed Pipe Scaled," by F. H. Stacey. If Mr. Stacey had arranged his feed pipe to provide two means of feeding the boiler, the trouble he relates would not have occurred. The pipe could have been arranged so that the boiler would receive feed water through the front head and also through the blowoff pipe. Then, should one of the feed pipes become scaled, the other could be used until repairs could be made at a convenient time, thereby preventing a shutdown of the plant.

I have my feed pipe arranged in this way and have not experienced any trouble. The feed pipe which goes through the front head runs above the top row of tubes within 24 inches of the rear head, then runs across the tubes up to the center row of tubes, where the water is discharged.

This boiler has been in service about three years and is practically clean, except where the feed water discharges between the center rows of tubes. In order to prevent any more accumulation of scale at this point, I have changed the pipe so that water is discharged between the tube and sheet. This was done about six months ago and the scale between the center rows of tubes is coming off nicely. By the time all this scale has disappeared, there will probably be an accumulation at the new place of discharge, but it will simply mean changing back the piping to the old place.

H. A. JAHNKE.

Milwaukee, Wis.

Worn Pump Screws

The reader has noticed an article in POWER of May 2, and is rather interested in some points that are not fully explained. The reader has been in charge of a plant containing large triplex pumps and would like to procure information in regard to the screw pump so as to gain some comparison as to the relative upkeep of the two kinds of apparatus.

Is it possible to pack the screw type of pump on ordinary time; that is, not on Sundays or nights when the plant is shut down?

How often is it necessary to pack the screw pump?

What has been your experience in regard to the expense of the packing of this type of pump?

In packing a triplex pump against big pressure it is easy to set the packing down too tight so that the electric power required to drive the pump is very much increased. Do you have the same trouble with the screw pump?

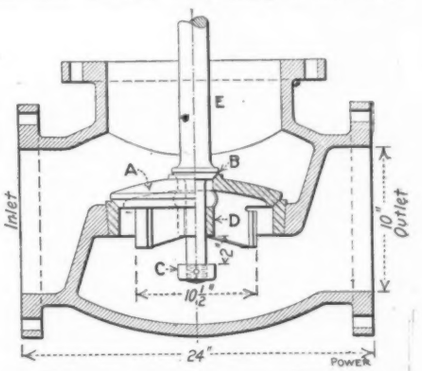
The reader would also be interested to know whether or not this type of pump requires continuous attention in regard to its oiling system.

GEORGE H. THOMAS.

Clen Ridge, N. J.

Special High Pressure Valve

The valve illustrated by A. Wind on page 574 of April 11 issue of POWER is a very good large-size type of valve. A few years ago I operated an engine with a throttle of this type. It was a 10-inch valve, and differed from the one shown, in that the valve stem was reversed. That is, it pushed the valve off its seat instead of pulling it off, with



VALVE WITH INTERNAL BYPASS

the advantage that when the valve was closed the pressure shut off the valve-stem packing.

Omaha, Neb. A. G. KNIGHT.

Specialists

The letter entitled "Specialists," by James Scotch, appearing in the issue of March 21, is, in my opinion, too critical and unwarranted. He blames the engineer in the small plant for exposing the mistakes of the specialists and dubs these engineers as "dinkies."

Mr. Scotch is apparently mistaken in reference to the object these engineers have in writing of such mistakes. I believe they write to warn unwary engineers of such pitfalls and not to pose as pedants or to unjustly criticize any specialist. There is always the young engineer starting in the business who will profit by the simple letters in POWER. He must start at the bottom and read carefully the simple questions asked in POWER every week—simple to those to whom they are familiar.

The fact that the bricklayer or machine erector probably has been doing such work for years, as Mr. Scotch states, does not make him infallible nor does it prevent the little engineer from knowing something about the business that the specialist does not know or happen to notice. To verify these statements I will relate an experience I had with one of these specialists.

An old locomotive-type boiler was to be inspected for the first time after I became engineer of the plant. I gave the boiler a good cleaning out, removed the grates, cleaned all the ashes and iron rust from the furnace sheets and found some very bad cases of rust on the lower parts of the water leg. A light blow with the peen of the hammer would dent the sheets.

This boiler inspector was really an expert, or specialist; he had worked many years at the boilermaking business before he became an inspector. Knowing this, I believed it would not be necessary for me to give him any instructions in his line of business. However, "a hint to the wise is sufficient" and I ventured to tell him to be a little bit particular and he might find something the matter with her.

When he got through he said that the boiler was all right except for some oil on the rear head at the upper row of tubes and told me that when I scraped it off I might run her as usual with 105 pounds to the square inch.

I then called his attention to the water leg. He started to pound it and feel for the thickness of the sheet; then started marking oblong figures on the sheets with white chalk. When he got through he took off his glasses, looked at me and said: "Don't start that boiler until there are seven patches on her and I have inspected her again."

The boiler was not started but was taken out and a new one replaced it.

My advice to all engineers in charge of plants is to keep your eyes open when other men are doing work in your plant, and for your own protection see that it is done right. The men doing the work may be careless or inexperienced, or they may be first-class mechanics but crowded with work and anxious to get at the next job or home on a short visit after an absence of several months. In any case, they are not infallible and will bear watching.

It is not necessary to be an expert in all branches of steam engineering in order to be able to detect whether a job is done right or radically wrong. Common sense, combined with the degree of intelligence that every engineer ought to have, should be sufficient.

JAMES W. BLAKE.

New York City.

Isolated Plant Engineering

The article published in the May 2 issue of POWER under the heading "Isolated Plant Engineering" is undoubtedly the strongest argument yet presented to show the true conditions which engineers in general have to face.

It is indeed a sad state of affairs that a large majority of men employed in steam plants are not permitted to know what the various expenses connected with the plant are, yet there are those who are kept in absolute ignorance of the price that is being paid for coal, oil, waste and supplies in general. Under such conditions as these, what chance has a man to know what it is costing to do certain work?

Furthermore, I would like to say that a big mistake is made when managers or superintendents who are not themselves engineers, but who have the hiring of such men, try to tell these men what to do, because any man who has had the necessary experience to fit him for the position knows far better than this type of manager what his duties as engineer are. Oftentimes much trouble and friction could be avoided if these men would allow the engineer to run his own department, and then if he was not doing his full duty in that respect the cost of maintenance would very soon make it known.

In regard to making suggestions for the betterment of the plant, I would like to say that many good engineering kinks submitted by the engineer are often credited to the manager later on when the work is carried to completion.

A little experience of mine was as follows: I had charge of a very poorly designed one-pipe heating system in an uptodate office building and found that a number of the rooms could not be properly heated on account of poor circulation. After considerable trouble and thought, I concluded that to overcome the trouble with the least expense it would be necessary to run the returns from the risers to a suitable tank and then pump them into the boiler instead of putting them into the sump, as had formerly been the practice. I submitted this arrangement to the agent, who took about a year to consider whether it was worth the expenditure of $100 or not, and after much agitation he consented to let me proceed with the work.

The work was completed just in time for the commencement of the heating season, and from the start the tenants remarked how much more comfortable their offices were.

After the installation had been working long enough to prove its reliability, the agent brought in several of his friends and explained how he had conceived the idea of saving so much good, hot water with a corresponding decrease in feed water as well as coal.

H. H. BURLEY.

Brooklyn, N. Y.

Writing for the Technical Papers

Referring to the advice offered by Mr. Williams, in the issue of April 25, to a recent correspondent on this subject, it would appear that the suggestions, in the main, might be materially improved. When you have a message, deliver it by all means, but in the delivering there is distinctly a right course and a wrong one; wrong, not only in point of view to the journal to which the matter is to be forwarded, but a greater wrong to oneself, inasmuch as each contribution should be an improvement over the one which has preceded it for personal benefit of its author. If one is deficient in some of the functions of letter writing and the like, there is no time like the present to endeavor to correct, and, in exercising a little care in the preparation, one not only has a possibility of having an article accepted, but he has a positive assurance that each one executed is helping to better his natural condition, is assisting in a general knowledge of the proper usage of words, correct spelling and the like.

Mr. Williams' statement, "Do not waste your time in rewriting; simply make all corrections in the first draft—" embodies a wrong principle. All know that "time is money," but time spent in a careful preparation of copy is far from wasted. Editors, as a rule, do not keep a "puzzle department" and one of the most important essentials for a just consideration of a contribution is its readableness, its ability to be quickly deciphered. A rough pencil draft should be made of matter which is to be presented, which one should try and divide into distinct parts, as introduction, or head, description, or body, and end, or tail, instead of a jumbled mass of material entirely out of order. This method is easy and sim-

ple and will not only help the writer in collecting what he wants to say, but will help the reviewer for publication in learning if what he has to say is worth while. In writing one should be brief and direct, make the letter read with full common sense in the fewest possible words; this does not mean "telegram" style, but, as steam is usually supplied to an engine by the shortest and best route, so should words be applied to the manuscript.

When matter is so collected in a rough draft, it should be copied plainly, on one side of the paper, of course, and with all neatness possible. This is not time wasted, this is time well spent. A rewriting in this manner shows, many times, how arrangement and wording may be improved, and it all helps; it shows where one can "cut" or add to good advantage. A little reasoning, such as "if I did not know this, would my reading of this article show me plainly," in description work, will oftentimes prove effective in bringing out little points not thought of and which may be necessary for completeness. Sheets should be numbered, as Mr. Williams states, but a title on the first page with a name and address on the last, and the whole held together with a common paper fastener, is far better and simpler than repeating such on each particular sheet.

An entirely wrong idea is obtained from "Do not be afraid of your spelling—," from this letter. Because a man is engaged in power-plant work in the operating end, is it any excuse why such carelessness should be shown in spelling, an elementary study compared with what his occupation demands? Is there any reason why he should not be fully as competent to spell simple words as a clerk or anyone else? A dictionary today is a cheap article, a small one, suitable to all practical purposes, may be obtained for a trifling sum, reference is an easy matter and a continual misspelling of the same word, with no attention given, shows the spirit that one is not alive to a betterment of his condition. Not only for contributions, but in record work and private correspondence to allow this "don't care" manner to predominate is unjust to oneself. When once a proper spelling is known, especially when it is looked up, it will come thereafter very easy.

In a paper such as POWER there is always a place for an article whether it be long or short, if it is worth while, if the matter is interesting or novel, if it is going to help its readers. If one knows something good, a kink, layout or otherwise, that he has not seen in print, he should write it up. Time-worn subjects unless presented in a particularly new and bright dress do not usually find place. Let the contribution work from both ends, make it serve two purposes; if it adds one dollar to the bank account, let it add many times this amount in value in perfecting system, neatness and an appreciation for the simple rudiments of the English language in its author. These are some of the things which help in getting the job higher up.

JOE SMART.

Los Angeles, Cal.

Coal Defined

Mr. Bement has an interesting article on "The Coal Problem Analyzed" in the April 25 number, but I must protest against his definition of the word "coal" as "that part of the fuel minus ash and moisture for which the term pure coal has been devised." It is all right for him to use the term "pure coal," if he likes it, to signify what others call "ash-and-moisture-free coal," since this term is not likely to be used with any other meaning, but it is all wrong to take the word "coal" which has had for hundreds of years a well known meaning, and limit it to mean only a part of what has hitherto been known as coal, and to invent for the latter a new term or terms, such as "fuel mixture" or "coal fuel."

The meaning that technical writers should give to a commonly used word is the meaning that is ordinarily given to it in commerce and literature, and that is found as the common definition in a modern dictionary.

Example: Coal (Century dictionary). "A solid and more or less distinctly stratified mineral, varying in color from dark-brown to black, brittle, combustible, and used as a fuel...Coal always contains more or less earthy matter, which is left behind in the form of ash after combustion...Sulphur is rarely if ever absent."

In other words, coal is the stuff that is called coal in the market. In the "Mechanical Engineers' Pocketbook," page 789, eighth edition, it is said that coal is composed of four different things that may be separated by proximate analysis, viz.: fixed carbon, volatile hydrocarbon, ash and moisture. The late Eckley B. Cox, in one of his papers on coal, once said, "Coal consists of two things, coal and dirt," meaning by dirt the visible pieces of slate and dirt which should be removed from the coal before shipping it.

Mr. Bement's Table 2 reads:

TABLE 2. PROXIMATE COMPOSITION OF COAL

Pure Coal = Combustible Elements + Non-combustible Elements.
Dry Coal = Pure Coal + Mineral Matter.
Moist Coal = Dry Coal + Water.

I would change it to read as follows:

TABLE 2. PROXIMATE COMPOSITION OF COAL

Coal = Dry Coal + Water.
Dry Coal = Pure Coal + Ash.
Pure Coal = Combustible Elements + Non-combustible Elements.

WILLIAM KENT.

New York City.

Engineers and Boiler Inspectors

In the April 25 issue I read Mr. Eaton's article on engineers and boiler inspectors. This brought to mind the question asked in an article in the April 18 issue, "Do you ever take time to examine the boilers of which you are in charge?"

Mr. Eaton writes that he does not touch anything inside of a boiler until the inspector has had an opportunity to see it in its operating condition. Would not this naturally lead the shrewd employer to think that the inspector and not the engineer, is the brainy one in the plant? It is because some engineers neglect to make examinations that most of our license laws are passed. These laws are safeguards for the public against explosions.

Some time ago I was in charge of a plant which apparently was in first-class condition. After an examination I found a defective boiler. This fact I made known to the office. The boiler had a number of leaking tubes and over the fire the seam showed up burned for a space of 2½ feet of the circumference of the shell. Stretched rivets and a crack in the plate showed up between two of the rivet holes to the edge of the plate, also a burned and buckled dry sheet which was subsequently straightened out with hot plates, sledges and flatters. The flange and rivets of the head were then calked tight and no trouble from leakage was afterward experienced. The rivets were in such bad condition that I insisted on their being replaced with new ones. Notwithstanding the condition of the seam over the fire, the only satisfaction I got from the superintendent of the plant was the statement that the boilers were insured and that the leakage would probably take up. I, therefore, immediately reported to the Hartford inspector of the district. New tubes were soon put in and a patch put on the defective seam over the fire.

The inspector's task is not always a pleasant one and the salaries of some are less than the salaries of chief engineers. It is unfair, therefore, to compel the inspector to stand four or five hours scraping scale off the seam and tube ends, crawling under boilers full of ashes and soot in search of fire cracks and other defects, which are visible only after every inch of the surface has been cleaned and scraped. Some engineers are in charge of boilers for long periods, without knowing that the feed pipe is partly plugged up or disconnected from the bushings in the front head. I always have our boilers cleaned out regularly. The back connections, tubes and hood are cleaned, as well as the bottom of the shell, the seam, rivets and stay braces. Thus, I am always ready for the inspector. I am in a position to report all defects as soon as he enters the boiler

room. Only in one instance did it require more than an hour for an inspector to examine our boilers.

Inspectors should be cultivated, for they are great aids sometimes in getting unsafe boilers repaired. Engineers should care for their plants and see that the boilers are kept clean and in a safe condition, without having to be told to do so by the inspectors. This is the best proof of their ability and gives them a reputation, not only among the inspectors, but keeps them in good standing with their employers.

R. A. CULTRA.

Cambridge, Mass.

The Benefit of Organization

Mr. Wallace, on April 4, opposing Mr. Gotstein's plea of March 14 for an organization, said, "Organization never raises wages." How, then, would he explain the substantial increases granted to every mechanic, except the engineer, during the last few years? I am positive that men with intelligence, aware of current events, would not honestly say that organization never raises wages. In one city alone, through organization, the wages of 68 engineers were raised $7 a week, for an eight-hour day.

The history of industrial battles for the last 50 years against oppressive methods of employers, proves conclusively that organization alone has reduced the hours of labor and increased wages.

Wherever and whenever an organization has had any semblance of strength, there has been a demonstration of its power. Surely no man is so lost to the trend of the times as to believe that Mr. Rockefeller, Mr. Carnegie, Mr. Morgan and others of their class made their millions by their own unaided efforts. It is a fact that will bear no contradiction that our millionaires now hold their positions by the aid of the most iron-clad organization the world has ever known.

Mr. Wallace states that engineers are not like other mechanics, and work under different conditions. Let us see if he is correct.

An engineer depends upon the sale of his brain and brawn for so many hours a day for wages. With these wages, which is the price paid for the use of that brain and brawn for eight, ten, twelve or more hours a day, he buys food, shelter, clothing, recreation, establishes a home and educates his children. Other mechanics sell the same things for the same price—wages—and purchase the same essentials for a normal working-class life. So far as the sale and the reason for the sale are concerned there is absolutely no difference between the engineer and other mechanics. The wage received is expended in precisely the same manner. Thus, there is a continuity of interests between all mechanics of all classes in both the sale of their brain and brawn and in the expenditure of the price received.

Mr. Wallace states that an engineer receives what he is worth without the aid of organization and quotes a few acquaintances who are receiving high wages. This is not at all a wonderful thing, confined alone to the ranks of the engineer. The same thing is true wherever there are unorganized mechanics.

In all important things of life the material interests of all mechanics are identical. The sole difference between engineers and other mechanics is that 90 per cent. of the engineers are holding down one-man jobs while other mechanics work in groups.

It is true that engineers are expected to cover a wider range of effort than other men, but this is due principally to the isolation of their positions. Oftentimes between whistle and whistle the engineer performs the duties connected with a dozen different trades. If he refuses, or is unable to perform them, he is either no good or lazy, or both.

This isolation, with the constant and insistent calls upon his knowledge and mechanical ingenuity, has bred in the engineer an egotism that is monumental. It is this very isolation that makes organization necessary for the engineer.

To be an engineer—a real one—requires years of study and experience, a close study of new mechanical devices which are day by day being placed on the market, physical strength, a cool, clear head, nerves of steel, the ability to act quickly, the courage to face death or injury in the interest of his employer, the endurance to work hour after hour without rest or sleep and the willingness to do so whenever necessary. And for these attainments he is paid less and is obliged to work longer hours than the members of a dozen other trades which are organized.

Mr. Wallace, to prove the uselessness of organization, points out one man who, when he was not satisfied with his pay, stepped out and secured a $6000-a-year job. This is one man of abnormal ability. We are not, however, dealing with abnormalities, but with the average normal, brainy, everyday engineer. Were all engineers like the gentleman Mr. Wallace cites, possessing just as much push and ability, there would be no $6000-a-year jobs. Wages are not based upon what the highest-priced man receives but what the most needy will consent to accept.

If organization is good for our employers, good for other mechanics, for doctors and lawyers, why in the name of common sense is it not good for engineers?

Therefore, as we are now living in an age of organization, from the lowest to the highest, including billionaires and tramps, it behooves the engineers of this country to keep abreast of the times, and organize.

Let me say to Mr. Gotstein that he need not look around for an organization; it is already at hand. Get into it. Keep your eyes open and help to place your fellow engineers where they belong.

GEORGE G. HALL.

Dorchester, Mass.

Standpipe on Heating System

In the letter published under the above heading in the May 9 issue, the statement is made that "The system is made up of 1-inch pipe." The sentence should have read, "The system is of the one-pipe design."—EDITOR.

Remarkable Overload Boiler Test

Referring to the article in the March 21 number on "A Remarkable Overload Boiler Test," some data are given below on a test of a Parker downflow boiler at the plant of the Colorado Fuel and Iron Company, Segundo, Colo. If the tests published in the March 21 number are considered remarkable for overload, the test of the Parker boiler at 234 per cent. of its rating should be of interest.

Kind of boiler	Parker Water Tube
Heating surface, sq.ft	2,650
Grate, Roney Stoker (8'3"x7'9") sq.ft	63.9
Duration, hours	7
PRESSURES (Average)	
Barometer, inches	23.3
Steam gage, lb	102.64
Draft gage, inches { comb. chbr	1.119
Draft gage, inches { furnace	0.308
TEMPERATURES (Average)	
Boiler room, deg. F	92.55
Escaping gas, degrees F	506.57
Feed water, degrees F	66.3
FUEL	
Kind of fuel	Frederick slack
Per cent. moisture	1.2
Per cent. ash of natural fuel	19.4
EVAPORATION	
Evaporation from and at 212 degrees, per lb. natural fuel, lb	7.90
Evaporation from and at 212 degrees, per lb. dry fuel, lb	8.000
Evaporation from and at 212 degrees, per lb. combust., lb	10.279
Evaporation from and at 212 degrees per sq.ft. grate, lb. per hour	335.21
Evaporation from and at 212 degrees per sq.ft. heating surface, lb. per hour	8.08
HORSEPOWER	
On basis 34½ lb. from and at 212 degrees	621.16
Builders' rating for boiler, h.p.	265
Overload, per cent. rating	234
Efficiency of boiler and furnace, per cent	59.1

No account of steam furnished stoker and fan engines.

The boiler tested is rated at 265 horsepower, having 2650 square feet of heating surface. It is equipped with a Roney stoker 8 feet 3 inches wide by 7 feet 9 inches long, 63.9 square feet. The duration of the test was seven hours, and it was conducted by a representative of the stoker company. Attention should also be given to the fact that the coal used in the test was of an inferior quality.

B. DIECKHAUS,

Parker Boiler Company.

Philadelphia, Penn.

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POWER

Longing for Old Times

The relative difference between the standing of the old-time engineer and the man who has charge of the modern steam plant is self-evident, even to the layman. And the steam plants that are operated by the two types of engineers stand apart in a marked degree, showing the difference between the old and the new.

A man who operates a small steam plant, does his own firing and attends to the chores about the place does not and never will hold a very exalted position among his fellow craftsmen. He may be all right for the place, but in the engineering world the place is not recognized.

It is but natural that the modern engineer should tower head and shoulders above the old-time runner, who is altogether too frequently a young man using old-time methods in an old-time plant because he does not bestir himself and know enough to hold a better job.

Although there is no attractive comparison between the two types of engineers, it is exceedingly strange that a correspondent should recently write a letter bemoaning the fact that the old-time men, who only knew how to start and stop an engine and shovel coal, are being ousted by men who understand electricity, hydraulics and the other subjects that are necessary for the successful engineer to know.

Such an attitude is not only unprogressive, but it is foolish. What engineer worthy of the name would go to work in some of the steam plants that boast of one engine and boiler? What incentive can there be for an ambitious man to long for the chance to work in a steam plant, starting an engine and firing coal? Nothing much to do, not much responsibility and very poor pay.

One might as well long for the days when houses were lighted by the flames in an open fire place, when the steam engine was used in its crudest form or when knives and forks were unknown.

No progressive man regrets the fact that he has been obliged to know about a number of engineering branches in order to assume charge of a modern steam plant.

Such knowledge has made him a better man in every way. More liberal and broader minded in his views, more conservative in his opinion and a more observing, careful, painstaking engineer.

All of this has perhaps cost him self-denial and long hours of solid study that might have been spent in pursuit of pleasure. There is, however, no gainsaying that the benefit has been all his own.

It is about time that engineers get away from the idea that they are an overworked and abused set of men. Because the design of the steam plant has been improved faster than some engineers have improved in engineering science is no reason why there should be regrets on the part of anyone that old conditions are passing away.

Let them pass. Get ready to take charge of the new power plant. Throw the old homemade box chair out of the door and get ready to take a place at the new plant and know how to hold down the cushioned armchair before the engineer's desk.

Radiated Heat

Popular belief regarding the insulating effect of a hollow furnace wall seems to have received a severe jolt as a result of the recent investigations of the Geological Survey, mentioned in the May 23 issue.

Heat may be transferred in three ways: by conduction, by convection and by radiation. The conductivity of air is known to be low, and where convection is eliminated by stopping leaks and preventing the circulation of air currents, an air space between the walls of a boiler setting is generally regarded as affording the greatest protection against the loss of heat to the boiler room. In view of the investigations, however, it appears that notwithstanding the low conductivity of air, its effect upon the transfer of heat is small as compared with that of radiation when high temperatures are concerned. This is because the transfer of heat by conduction varies directly as the temperature difference between the two inner surfaces of the walls and the resistance of the intervening air, whereas the radiation varies directly as the difference between the fourth powers of these surfaces.

This may appear somewhat startling at first, but when it is considered that the heat given to the earth by the sun is transmitted by radiation alone, the significance of this factor is at once apparent. Furthermore, when standing in front of

an open fire the heat is felt upon the face, yet the temperature of the intervening air may not be materially increased; but if a piece of paper or other shield is placed in front of the face the heat will not be felt. This shows that it is radiated heat. Also, the heat from an incandescent lamp is radiated as the bulb contains very nearly a perfect vacuum.

Some may find it hard to harmonize this with the fact that there are certain vessels on the market for keeping things hot or cold, which have double walls with a partial vacuum between. The fact is, however, that the walls of these vessels are polished and reflect the heat. If it were practicable to do this with furnace walls, one source of heat loss might be greatly minimized. The whole subject is one of unusual interest and should evoke profitable discussion.

Room for Improvement

Ever since Newcomen started his first pumping engine it seems to have been understood that the engineer would stand for more overtime and other undesirable conditions than anyone else around the plant.

It is taken for granted that he will be the first on the job in the morning, the last to leave at night; that he will spend all day Sunday at the plant and work for laborers' wages. This has gone on until after two hundred years' of precedent and practice the bargains that some employers are able to drive with their mechanical help seem almost beyond belief. The following is an example:

This is the case of an "engineer" who runs a machine in a shop. He is an expert on the machine and, although he has some other duties to look after, he turns out nearly as much work as his companions who keep steadily at their tasks. These "other duties" consist of wheeling the coal, firing, and hoisting the ashes for a two-hundred-horsepower heating boiler and attending to a gas engine which runs the shop. The engine runs night and day, shutting down a half hour for the noonday lunch and a half hour in the evening for a change of shifts.

During lunch time the "engineer" tinkers around the plant between mouthfuls and sees to it that the machinery is started for the afternoon run. At night he remains to put the plant in operation for the night run. On Saturday afternoons he works on the engine, getting it in shape for the next week's work, and comes down on Sunday to work around the boiler, lace belts, rebabbitt the line shafting or do any odd jobs of plumbing on the heating system.

For his extra duties he receives twenty-five dollars per month, which helps to pay the rent, and he makes up the rest of his living by hustling on the machine. As an example of industry he is a model; as an example of poor engineering conditions his case could not well be improved upon.

It has often been remarked that this country affords a wonderful field for activities of every description; that there is scarcely a line in which one may enter but what virgin soil may not be encountered.

This is particularly true of all those organizations which have for their object the betterment of the individual. Each is endeavoring in one way or another to better the condition of its members and incidentally the profession in general, and in this work there is no question but that great good is accomplished.

Much time and hard work are necessary to dig down into the depths and reach some individual cases, but with such conditions as cited above existing the possibility of reward is always present; the horizon is limitless; the field has hardly been scratched.

All in the Spirit

One of the arguments frequently advanced in favor of the enactment of engineers' license laws and ordinances is that it will act as an incentive to the engineer to study the fundamental principles of his calling. This may be true of the man who is an engineer because accident led him to the power plant in his search for something to do in order to get a living and who still works for a living and nothing else. It is not true, however, of the engineer who follows his vocation because he loves it. He strives and studies not because of the spur of the license but to fit himself for the highest position possible. His ambition is not alone to hold a license, but to become better educated, a better engineer and a better citizen every day of the year. He does not expect that a law, which unless properly administered will not eliminate the unfit, will place an arbitrary value on his services, for he aims to give value received for every dollar paid by perfecting himself in both the theoretical and practical knowledge of his work.

There were good engineers before the days of license legislation and there are good engineers in those States and cities where there are no license laws. It will be found, however, that it is the progressive and able engineer who is always advocating the passage of license and inspection laws. His knowledge of the dangers attendant on the operation of steam boilers and engines, his appreciation of the possibilities in the loss of life and limb and the damage to and destruction of property and his regard for the safety of others make him the foremost of all advocates for rational license and inspection laws and their administration in the spirit for which they are intended. He does not advocate license laws for the purpose of limiting the supply of competing workers in his field, for none can be found more ready to give effort and time to help another than the real engineer, but because he loves and honors his calling. It is his chosen work and he gives to it the best that is in him and all of it, because to him to be an engineer is to live.

Boiler Horsepower

The new value for the heat of evaporation from and at 212 degrees throws out the American Society of Mechanical Engineers' standard for a boiler horsepower. That standard is 30 pounds of water at 100 degrees evaporated per hour into steam at 70 pounds pressure above the atmosphere.

Or 34½ pounds, evaporated per hour from and at 212 degrees.

Or 33,305 B.t.u. per hour. The first two never did agree and with the corrected heat values the evaporation of 34½ pounds from and at 212 degrees means 33,478.8 B.t.u. instead of 33,305.

Why not leave any consideration of the horsepower of boilers out of the forthcoming (?) report. It is an anachronism and ought to have no further official recognition. Let them be rated in direct terms of the water which they will evaporate from and at 212 degrees per hour. We do not buy condensers by the horsepower.

At the experiment station of the United States Bureau of Mines, Pittsburg, Penn., several trial runs have been made with an experimental gas producer, using coke as fuel, with which limestone has been mixed in varying proportions, the purpose being to flux the ash, and form a liquid slag, thus avoiding clinker and ash troubles and consequent shutdowns. Liquid slag has been readily made which runs freely from the producer. The high temperatures necessary are very efficient in the generation of gas.

It seems that our numerous references to the self-contained outfit which the Europeans call the Locomobile and with which they obtain such wonderful efficiencies have had their effect. It is said that a number of large American companies are considering their manufacture.

The weather has now reached the point where the back door can be kept open, all ready for the speedy exit of the man who tries to sell you one of those gas engines that "require no attention."

Just because warm weather is coming is no reason why you should close your books and let your studies go for another six months.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Flow of Air through an Orifice

A vacuum of 7½ inches of mercury is maintained in a tank while air rushes in from the outside, passing through five ½-inch openings. Required the velocity of the air through the openings and the quantity of air entering per minute.

G. H. W.

The velocity in feet per second is obtained from the equation:

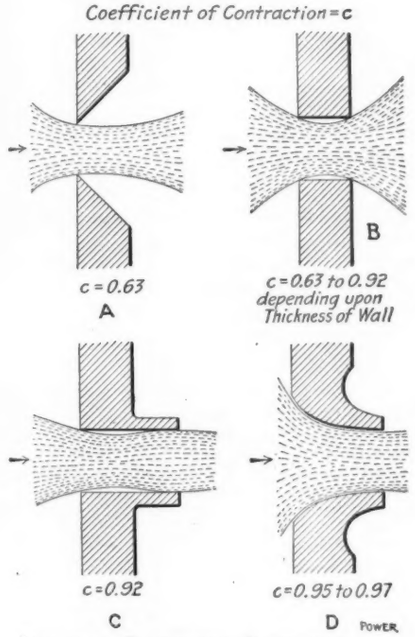
$$\frac{v^2}{2g} = \frac{k}{k-1} p_o V_o \left[1 - \left(\frac{p}{p_o}\right)^{\frac{k-1}{k}}\right] \quad (1)$$

where,

v = Velocity;

p_o = Atmospheric pressure in pounds per square foot;

p = Pressure in tank, in pounds per square foot;



JETS WITH DIFFERENT COEFFICIENTS OF CONTRACTION

V_o = Specific volume of air at atmospheric pressure and temperature t_o, degrees Fahrenheit;

$g = 32.18$;

k = Ratio of specific heat at constant pressure to that at constant volume.

With the barometer at 29.92 inches,

$p_o = 14.7 \times 144 = 2117$ *pounds per square foot*

Corresponding to a vacuum of 7½ inches of mercury,

$p = 11.01 \times 144 = 1585$ *pounds per square foot*

The value of V_o depends on the temperature and the humidity of the air. Leaving aside the effect of humidity, 12.83 cubic feet equals the volume of one pound of dry air at 50 degrees Fahrenheit; then

$$V_o = \frac{12.83 \times (460 + t_o)}{460 + 50}$$

Substituting this value of V_o in equation (1),

$$v^2 = \frac{2 \times 32.18 \times 2117 \times 12.83 \times (460 + t_o)}{510} \times \frac{1.41}{1.41 - 1}\left[1 - \left(\frac{1585}{2117}\right)^{\frac{1.41-1}{1.41}}\right]$$

Whence,

$$v = 30.85\sqrt{460 + t_o} \text{ feet per second}$$

The volume flowing per minute through a ½-inch opening equals

$$60 \times \frac{d^2 \times 0.7854}{144} \times v \times \text{coefficient of contraction}$$

expressed in cubic feet of air at p pounds per square foot pressure or at 7½ inches vacuum.

To obtain the volume of free air at atmospheric pressure and a temperature t_o, let t be the temperature in the tank; then

$$t_o - t = \frac{A \times v^2}{c \times 2g}$$

where,

A = Heat equivalent of work = $\frac{1}{778}$;

c = Specific heat of air at constant pressure = 0.2375;

$$t_o - t = \frac{v^2}{0.2375 \times 778 \times 64.36} = \frac{v^2}{11{,}900}$$

The tank temperature is

$$t = t_o - \frac{v^2}{11{,}900}$$

The volume V discharged into the tank at the temperature t and pressure p is equivalent to a volume V_o of free air at a pressure p_o and temperature t_o.

$$V_o = \frac{V \times (460 + t_o) \times p}{(460 + t) \times p_o}$$

cubic feet per minute.

Joint Resistance of Parallel Circuits

If a conductor of 20 ohms resistance, one of 22 ohms and one of 25 ohms be connected in parallel and 110 volts applied to the terminals, what current will flow in each one and what will be the joint resistance of the three?

C. H.

The current in each conductor will be exactly the same as though the other two did not exist. By Ohm's law,

$$\frac{Volts}{Ohms} = Amperes$$

therefore, the current in the three branches will be 110 ÷ 20 = 5.5 amperes, 110 ÷ 22 = 5 amperes and 110 ÷ 25 = 4.4 amperes, respectively. The total current in all three branches will be 5.5 + 5 + 4.4 = 14.9 amperes, and the joint resistance, therefore, is 110 ÷ 14.9 = 7.38255 ohms, or practically 7.4 ohms. The joint resistance can also be figured by adding the reciprocals of the three resistances and taking the reciprocal of the sum. Thus, the reciprocal of 20 is 0.05; the reciprocal of 22 is 0.0454545; the reciprocal of 25 is 0.04. The sum of these is 0.1354545, and the reciprocal of that is 7.38255.

Boiler with Little Water

Supposing a 60-inch by 16-foot horizontal-tubular boiler with 48 four-inch tubes was fired up with several inches of water in the boiler. The water at about 100 degrees. Would it be possible for this water to be evaporated into steam and cause the safety valve loaded at 80 pounds to blow off. In other words, would it be possible for the small amount of water in the boiler to be expanded into steam to cause a pressure of 80 pounds, providing the boiler held tightly; also, would this be likely to happen within 25 minutes from the time of starting the fire, coal being used as fuel?

O. C. D.

A boiler 60 inches by 16 feet with 40 four-inch tubes has a capacity of 260 cubic feet. Steam at 80 pounds gage pressure weighs 0.2188 pound per cubic foot. Therefore it will require the evaporation of 0.2186 × 200 = 56.89 pounds of water to fill the boiler with steam at 80 pounds pressure. A depth of water of one inch at the bottom of the boiler would contain 60 pounds or enough to blow the safety valve and then have some water left. It should be an easy matter to boil so little water in much less than 25 minutes with a good coal fire.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Charging a Refrigerating System

By F. E. Matthews

How should a refrigerating machine be charged, and how is it possible to tell when it is sufficiently charged; also, when it needs recharging? What are the various systems? What will prevent brine from freezing in the pipes, and how can they be opened after freezing?

Although not specifically stated in the question, the machine is probably of the compression type, and on this assumption proceed as follows: Connect the shipping drums of anhydrous ammonia, one at a time (or more if the plant is of large capacity or the initial charge is being put in and one wishes to save time), to the charging valve usually placed between the master expansion valve on the liquid line, where it leaves the receiver, and the expansion coils or brine cooler. This connection is most easily made by a special fitting built up with two swing joints, one end threaded to fit the valves on the shipping drums and the other provided with a flanged or threaded end to connect to the charging valve. When the connection has been made the air in the pipe may be expelled by slightly opening either the charging or the shipping-drum valve and loosening the flange swing joint nearest the opposite end.

The connection having been carefully made, the main valve on the receiver is closed and the low-pressure side is "pumped down" by allowing the compressor to continue operation after the liquid has been shut off. By the "pumping down" process the ammonia in the expansion side of the system is compressed and discharged into the compression side of the system, where it is condensed and flows to the liquid receiver which it may fill as well as the lower pipes of the condenser.

When the low-pressure gage indicates that the pressure in the expansion coils has been reduced to zero, or atmospheric, pressure, the charging valve may be opened wide and then the valve on the shipping drum may be "cracked," allowing a small stream of the liquid to pour into the system. The valve on the drum virtually becomes the expansion valve of the system and its manipulation should be governed by the same rules that govern the other expansion valves when the machine is in normal operation, except that it is better not to carry the back pressure quite as high as usual. This pressure may be anything above atmospheric, but it is not advisable to go below atmospheric as the vacuum would tend to draw air into the system through the charging connection when the drum is disconnected if the charging valves are not absolutely tight. A considerable inrush of air is not so easily detected as the slightest leak of ammonia outward.

When an open connection is made between the shipping drum and the system, the liquid is forced out of the drum into the system by the pressure of the gas above the liquid just as water is forced out of the blowoff of a boiler by the steam pressure above the water. The only difference is that it requires a higher temperature than that of the atmosphere in the engine room to raise steam pressure, while any temperature above zero will give a pressure above atmospheric in the case of ammonia. The pipe line from the drum valve will frost while there is liquid flowing. The melting and dropping off of this frost is an indication that the drum is empty. Frost may also appear on the bottom of the drum. The end opposite the valve is usually slightly elevated so that the liquid will flow to the outlet pipe which enters the head and turns down within about an inch of the cylinder side. When one drum is emptied, shut both valves and disconnect the pipe connection; then place another drum in circuit if more liquid is needed.

In systems of medium and large capacity it will be found necessary to slow down the compressor during the charging operation to prevent the pumping of a vacuum.

It is easier to form an opinion as to the amount of ammonia that the system needs while it is operating than it is to determine when a sufficient amount has been added. Except in initial charges, in which case the company supplying the machine calculates the amount of ammonia required from the number of feet of pipe on the low- and high-pressure sides, it is better to add a comparatively small amount of ammonia and then operate the system for a sufficient length of time to restore normal conditions. The hight of the liquid in the gage glass of the receiver, or the general performance of the plant when no gage glasses are used, will give the engineer an idea as to whether more ammonia is required. There should always be sufficient liquid ammonia in the receiver to insure a solid stream at the expansion valve. It should be remembered that refrigeration is produced by the absorption of the heat required to change the liquid ammonia to a gas and since it takes only a very small amount of heat to raise the temperature of any gas that passes the expansion valve in company with the liquid, little cooling effect can be expected from the gas. The passage of gas with the liquid can usually be detected by the intermittent whistling sound at the expansion valve, the flow of the liquid being almost noiseless.

Refrigerating systems may be classified first, as to the working fluid, and, second, as to the method of operation. The most common refrigerating fluid is ammonia, the next is carbon dioxide, after which come air, sulphur dioxide, Pictet fluid, sulphuric ether and a few others little used in practical refrigerating systems.

Ammonia systems are operated either according to the compression or to the absorption system, the former being far in the majority. Either of these may be operated on the direct-expansion principle in which the working fluid is conveyed direct to the rooms or tanks to be cooled, or by the brine-circulation system, in which the refrigerant is used in a suitable brine cooler for cooling either salt or calcium-chloride brine which is then circulated through the rooms or tanks to be cooled.

These systems might be further classified as to the type of apparatus employed for converting the refrigerant from the gaseous to the liquid state and the means of utilizing the heat-absorbing power of both the primary (the refrigerant) and the secondary (brine) cooling media. Where brine is employed as a circulating medium, it is usually chosen because it can be more conveniently handled in the compartments to be refrigerated than can the primary refrigerant and because the primary refrigerant can be expanded more efficiently in a single brine cooler especially designed for the purpose than it can in a number

of dissimilar expansion coils scattered throughout the various rooms; also, where a brine-storage tank of large capacity is employed, it permits a considerable amount of refrigeration to be stored away during the periods of operation of the system, to be used during periods of rest, as, for instance, where it is desired to operate the principal mechanical equipment of the plant during the daytime only.

Brine is employed instead of water (which would otherwise be used on account of its cheapness) because its density may be so increased by the addition of salts that it will not freeze at the usual temperatures required for cooling. Water will transmit more refrigeration per pound pumped than brine and may be used where cooling at a high temperature only is required and the operating pressure of the primary refrigerant can be carried sufficiently high to insure against the water freezing. This condition could not be realized in the majority of cases, as any pressure of the ammonia below 47 pounds gage will produce a corresponding temperature below 32 degrees Fahrenheit, the freezing point of water. For lower temperatures salt brine is employed, its maximum density being sufficient to insure against freezing at temperatures above zero where tank systems are employed and the brine is kept in circulation. When still lower temperatures are required calcium-chloride brine is employed which at its maximum density is safe against freezing at all temperatures above 25 degrees Fahrenheit. At their maximum densities salt brine and calcium-chloride brine contain by weight respectively 25 per cent. of salt and 33 per cent. of calcium chloride.

To insure against freezing of brine, care must be taken to see that the solution is sufficiently strong to have a freezing temperature above that which will ordinarily be produced by the refrigerating machine. Care must be taken to see that this strength is maintained, as in the case of ice tanks a considerable dilution occurs through the replacing of wet cans and possible overflows due to occasional failure of automatic can fillers to shut off the sweet water at the proper time.

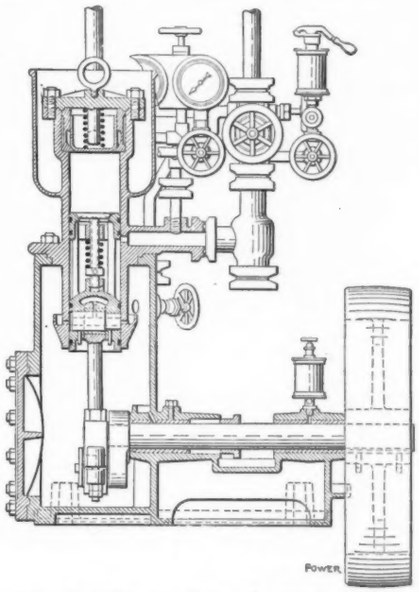
In the case of brine tanks slight freezing of brine on the outside of the expansion coils has no worse effect than that of insulating the pipes, reducing both their efficiency and capacity for cooling until the expansion can be shut off and the brine temperature allowed to rise sufficiently to melt the ice.

In the case of brine coolers a solid freeze may burst the pipes, allowing the refrigerant to escape into the brine and the brine into the refrigerating coils if the system is pumped down while leaks still exist. In both the brine tank and the brine-cooler system care should be taken to insure against abnormally low back pressures being carried when the brine pump is not in full operation. While it is always better to work on a safer margin, it is nevertheless a fact that brine can be circulated at its freezing temperature provided sufficiently brisk circulation is kept up to carry it away from the brine-cooling surfaces before the liquid brine, between any ice crystals that may form, has time to congeal.

When coils have been allowed to freeze up solid, the temperature in the cooler should be allowed to rise until the coils are freed, care being taken to see that the brine pressure is kept lower than that of the refrigerant so that the brine will not be forced into the system if leaks have been produced by the freezing. A careful examination of the brine flowing from the coils will show whether or not the higher-pressure refrigerant is escaping.

Vilter Vertical Single Acting Ammonia Compressor

The Vilter Manufacturing Company, Milwaukee, Wis., has just completed the design of a line of belt-driven, single-acting, ammonia compressors for use in small refrigerating plants. In this design the base, main bearings and crank case



VILTER SINGLE-ACTING AMMONIA COMPRESSOR

are in a single massive casting, making possible rigid construction and a low center of gravity. These units are built in six different sizes from 4x6, to 9x9 inches of compressor displacement and require a small amount of head room and floor space for their rated capacity.

The compressor, water jacket, suction and discharge pipe are cast as a unit, the suction entering the cylinder at a point near the center of the bore and meeting the ports of the piston.

As will be evident in the sectional drawing, the piston is of the double-trunk design, having long ports between the upper and lower sections, which register with the suction-gas inlet at all points of the stroke, allowing ample gas passage to the compression end of the cylinder but preventing entrance of liquid or gas to the crank case.

The suction valve, contained in the piston as shown, is made of hammered steel, finished and ground to its seat. All superfluous metal is hollowed out from the disk and the valve stem is drilled the full length in order to lighten the valve and render it responsive.

The discharge valve is a light-weight cup-shaped, pressed-steel member, housed in a semisteel cage and fitted into the upper counterbore of the cylinder. Both valves are extremely light in proportion to their size, are large with relation to the cylinder bore and give full area of opening from ⅛ to ¼ inch extreme lift, thus insuring full cylinder charging and noiseless operation.

For lubrication a hand oil pump is furnished for the upper part of the cylinder. An oil cup or grease box is supplied on the bearing next to the band wheel, while the main bearing, crank pin, wristpin and lower part of the trunk piston are automatically lubricated by oil splashed from the crank case. A gage glass is used to indicate the level of the oil in the crank case.

A strong feature of the design is the accessibility of all parts. By the removal of the large crank-case cover and the cylinder head the entire mechanism may be inspected or the parts disassembled. The same controlling features are used as are furnished with the large machines of Vilter manufacture.

Repairing Pipe Insulation

How can the sweating of pipe be prevented? In the plant I am operating it has caused the partial disintegration of the 3-inch cork covering. Will wrought-iron pipe painted or galvanized pipe remedy the trouble?

Unless the pipe has actually rusted through, the moisture encountered does not come from the inside. There is no such thing as sweating through a pipe. The so called sweating of cold surfaces is due to the cooling of the surrounding air by contact with the cold surface. Air always contains a certain amount of humidity, or, in other words, there is always mixed with air a certain amount of water vapor. The capacity of the air to carry this vapor depends directly on the temperature. The warmer the air the more vapor it will hold; the colder, the less. When air is saturated with vapor, that is, when it has absorbed all the vapor it can at a given temperature, the slightest drop in temperature will produce precipitation or a throwing down of a part of the moisture. If, on the

other hand, the temperature rises, the air will no longer be saturated, and a capacity for absorbing more moisture will have been created.

The temperature at which air becomes saturated to the point of precipitating its moisture is known as the "dew point." When drops of water appear on a cold brine pipe, or, in fact, on a pitcher of ice water, it is because the layer of air immediately surrounding the cold surface has been chilled below the dew point and thus gives up a part of its moisture.

In the case of a cold pipe insulated with cork or other kinds of covering, the liability of the air to be cooled to the dew point is greatly reduced, since the temperature of the outside of the covering is not nearly so low as that of the pipe. Nevertheless, a condition of atmospheric humidity will sooner or later exist when contact with a surface only a degree or two colder than the air will produce precipitation. If there is even the smallest opening through the waterproofing on the outside of the covering, air will enter, and, since the further it passes into the covering the lower the temperature encountered, the more likelihood of precipitation.

When the moisture has once been precipitated in the small openings through the waterproofing, it has limited exposure to the air for reëvaporation and unless there is a rise in temperature to increase the absorptive power of the immediately surrounding atmosphere, it will remain there. If the temperature of the insulation finally falls below 32 degrees, the moisture is frozen and in so doing expands, cracking the insulation still further, and into these minute cracks the moisture flows when another rise in temperature melts the ice. A recurrence of the freezing operation still further tends toward the disintegration of the insulation and the more the moisture penetrates toward the pipe and the more frequent the variations in temperature the more rapid will be the destruction of the insulation.

The place for the waterproofing, or more accurately, air proofing, of all kinds of cold insulation is where it comes in contact with the air and not at the point most remote from the point of attack, as in the case of the application of waterproof paper, paint, etc., next to the surface of cold pipes, where the only possible function of such waterproofing would be to prevent the pipe from rusting after the insulation had been penetrated and rendered useless by moisture.

If the present pipe covering is badly disintegrated and shows signs of being frozen, it should be removed and replaced. If it only shows deterioration in places, it can possibly be dried out. If there is any time of year when the pipes are not in service for a considerable length of time, they may be disconnected and the drying operation accomplished by passing steam through them. When the insulation has been thoroughly dried, the outside should be given a good coat of rubber sealing compound, supplied by the manufacturers, or several coats of quick-drying asphalt paint.

LETTERS

Corrosion in Refrigerating System

In the issue for April 11, comments are invited on the rapid deterioration of a brine-concentrating coil and tank, such as are used in connection with wet-air coolers. The following suggestions are offered for annihilating or at least greatly reducing the difficulty:

The first improvement that can be made is to pass only hot water or at most exhaust steam, not live steam, through the heating coil, so that the temperature of the brine will not exceed, say, 110 degrees Fahrenheit. This will prevent rapid formation of salt crystals on the pipes.

Secondly, the tank should have a large brine surface so that the surrounding atmosphere can absorb the rising water vapor as fast as possible. Let drafts of air pass over the surface, and do the work of concentrating when the humidity of the air is low. If the brine can be kept in motion by means of an agitator or circulating pump it will be an advantage, as it hastens the process of evaporation.

Third, arrange the heating pipes in form of an upright coil in the pan over the brine level, with a V-shaped distributing trough along the top, in the same manner as with an atmospheric type of condenser; and with a small pump keep circulating the warm brine over the coil until the solution has attained the proper strength. It is evident that under this method the atmosphere has a good opportunity of assisting in the work. With steam the heating surface of the coil should not be less than 0.11 square foot per ton of refrigeration; with hot water this surface may have to be doubled.

Fourth, for hygienic reasons it is objectionable to use the same stale brine over and over again; a slight overflow should be permitted to waste and this must be replaced with fresh brine. This can best be prepared by means of a box or barrel fitted with a false bottom, perforated. The water enters the barrel below the false bottom, rises through the salt above it and passes out as strong brine at the overflow pipe near the top of the barrel. This outlet must have a filtering screen to prevent obstructions from getting into the pipe. As it is frequently the impurities which cause rapid corrosion, the fresh brine should next be passed through a filter so as to remove these impurities. As a further precaution, the brine should be allowed to settle for some time in a tank of large area, where more impurities will precipitate to the bottom. At this opportunity it would be well to neutralize the corrosive properties of the solution by adding, in the case of salt brine, one to two pounds of carbonate of soda per 100 pounds of salt used, or one-half pound hydrate of soda per 100 pounds of calcium used in the case of chloride of calcium brine.

Fifth, as the expense for heating the brine and evaporating the water is considerable in a large plant, an economy can be effected by letting the hot discharge gas from the compressor pass direct through the concentrating coil. The coil should be made of extra-heavy pipe, galvanized on the outside only, and of sufficient cross-sectional area so as not to impose undue resistance on the gas. This plan will require very little attention and saves heat and condenser water.

Sixth, if this arrangement is not convenient the efficiency of the plant can be improved by means of a heat exchanger, in which the cold brine coming from the air cooler exchanges heat with the warm brine leaving the concentrator, in the same way as is done with the liquors of an absorption-refrigerating plant. In order to be able to advise as to the surfaces needed for a heat exchanger, one must know the temperatures and quantities of each medium available per hour, also the relative densities. In this connection it is well to bear in mind that it is important to work with brine just dense enough to prevent formation of ice on the ammonia coils. In order to see that this is the case, one must test the specific gravity of the solution every day by means of a hydrometer, and be guided by a table which gives the correct relations between specific gravity, freezing points and working temperatures of the salt or calcium brine used in the system.

CHARLES H. HERTER.

New York City.

With reference to the article, "Trouble with Refrigerating System," in the issue of April 11, the author has had trouble with brine rusting the boiling tanks and coils. Most of the trouble is caused from the fact that the brine does not let the tank dry when empty and the air rusts the moist iron. If the tubes fail at the fittings, it is due to electrolysis in the brine solution, which does not leave the tubes when they are apparently dry. If the tank is covered and copper coils used or perhaps a jacket, the trouble from corrosion of the tanks or from electrolysis will disappear.

F. G. WHEELER.

Trenton, Mich.

The Ohio Society of Mechanical Electrical and Steam Engineers

The twenty-third meeting of the above society was held at Youngstown on May 18 and 19, in the auditorium of the Elks Club, the privileges of which were extended to the visitors during their stay in the city. Six excellent papers were presented and discussed, of which those of interest to POWER readers will be treated in the columns following and in a later issue.

Inspection trips were made to the works of the Youngstown Sheet and Tube Company and to the Ohio works of the United States Steel Corporation, and outside of the formal program visits were arranged to the power station of the Youngstown Consolidated Gas and Electric Company of which Vice-President H. L. Patterson is mechanical engineer, the works of the William Tod Company and other local industries.

The next meeting will mark the tenth anniversary of the organization of the society, and will be held in November at Canton, where the first meeting took place.

Hydroelectric Developments in Ohio

BY PAUL M. LINCOLN

Reliability and continuity of supply is the first requisite for any power development. In former years the grist mill or sawmill was more or less common on many of the streams in Ohio. These operations required a comparatively small amount of power, and the continuity of supply was, under the conditions then existing, not absolutely necessary for success. However, most of these small developments of power have fallen into disuse.

A study of the rainfall and runoff conditions that apply to the Middle West is essential in arriving at a proper valuation of water powers. Table 1 shows the mean rainfall and runoff as recorded for the Muskingum River basin at Zanesville, O. This record covers the eight years of 1888 to 1895 and also shows the average of the same quantities for the three dry years of 1889, 1894 and 1895.

For the three months of August, September and October, the runoff reaches a comparatively low figure. A better idea of the conditions will be obtained by referring to the curves in Fig. 1, which show in dotted lines the average for the three dry years and in solid lines the average for the eight years. Referring to the months of August, September and October of the three dry years, it will be noted that the average monthly runoff amounts to 0.131 inch. Considering that this is the average for nine months (three consecutive months of three different years) it is certainly not too radical to assume that one cannot depend upon a continuous amount of water at the minimum flow of the stream of more than 0.1 inch per month. As a matter of fact, it is quite probable that this estimate is higher, rather than lower, than what would actually be obtained.

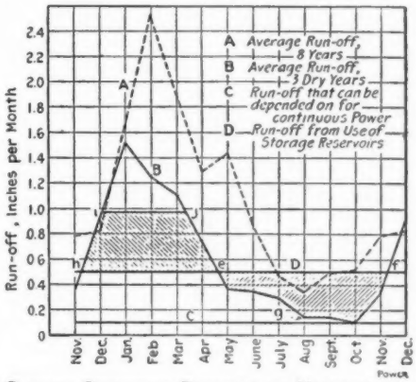
The table shows that the average rainfall, if distributed equally throughout the whole year, would amount to about 3.3 inches per month and that the average runoff for the same conditions would be about 1.1 inch per month.

One square mile with a runoff of 0.1 inch per month, falling through a head of

TABLE 1

Month	Mean for 8 Years, 1888 to 1895 Inclusive		Mean for 3 Dry Years, 1889, 1894, 1895	
	Rainfall, Inches	Runoff, Inches	Rainfall, Inches	Runoff, Inches
December....	2.34	0.821	2.37	0.910
January.....	3.27	1.605	3.24	1.521
February....	3.34	2.529	1.80	1.241
March.....	2.85	1.907	1.93	1.104
April.....	2.69	1.274	2.15	0.739
May.....	4.33	1.426	3.02	0.371
June.....	4.42	0.870	3.26	0.349
July.....	3.85	0.467	3.21	0.296
August.....	3.25	0.338	3.13	0.148
September...	3.22	0.448	3.56	0.140
October.....	2.87	0.502	1.97	0.105
November....	3.22	0.778	3.44	0.334
Totals.....	39.65	13.005	33.08	7.258

1 foot, will give a theoretical energy of about 0.01 horsepower. Taking into account the efficiencies of the waterwheel and such other apparatus as is necessary to utilize this power, it is evident that a continuous supply can be obtained of not more than 0.005 kilowatt for each square mile of drainage area for each foot of fall over which this


A Average Run-off, 8 Years
B Average Run-off, 3 Dry Years
C Run-off that can be depended on for continuous Power
D Run-off from Use of Storage Reservoirs
Run-off, Inches per Month
Nov Dec. Jan. Feb Mar Apr May June July Aug Sept. Oct Nov. Dec.

CURVES SHOWING RUNOFF OF MUSKINGUM RIVER

water can be used. For instance, if it were possible to obtain a point at which the runoff from the entire State of Ohio (41,060 square miles) could be utilized over a 10-foot fall, it would be possible to obtain a continuous power supply of only about 2000 kilowatts at the minimum flow point. This seems an astonishingly small result but is nevertheless true when it is conceded that a runoff of 0.09 foot per second per square mile is all that is available.

The foregoing figure is for a continuous power supply. As a matter of fact, actual conditions do not demand a continuous supply throughout all hours of the day. Considerably more power is demanded at certain hours than at other hours, and for an ordinary lighting load a 30 to 40 per cent. load factor might be expected. Only a relatively small amount of pondage is necessary for equalizing a continuous supply of water so as to take care of the variations in daily load demanded by a daily load factor of 30 to 40 per cent. This would increase the maximum power which would be available at certain hours of the day by conserving the water for the remainder of the day. A 30 per cent. load factor would mean that 3⅓ times the continuous supply can be depended upon at the maximum demand.

There are two plans which may be adopted for the utilization of such water power as is available in relatively flat and variable rainfall localities: The first is to build reservoirs for the purpose of impounding the water during flood periods and releasing it during the low-water periods; the second, to use water-power plants as auxiliaries for steam operation, depending upon each kind of plant as a relay for the other.

Referring to the first of these remedies, suppose, for instance, that it is desired to increase the runoff available from 0.1 inch per month, which represents about 45 per cent. of the average runoff. The curves in the figure indicate in a general way what is necessary. The line *C* shows the low-flow period of the stream, namely, 0.1 inch per month. The line *D* is drawn at the average flow point of 0.5 inch per month, and the area *e f g e* represents the amount of water which would have to be released during the summer months of the average dry year to raise the flow from what records show really does exist during such years to the 0.5 inch per month. In order to release this amount of water, it would be necessary to impound an amount of water indicated by the area *e h i j e*. On account of the losses which necessarily take place by evaporation and seepage, it would be necessary that the amount of water stored exceed that released by about 20 per cent.

If the water-power plant be considered simply as an auxiliary to a steam-power plant, it at once becomes necessary to install duplicate machinery for a considerable part of the load. Steam-driven machinery must be provided to carry the load during the periods of insufficient water. The question at once arises, will the installation of a water-power plant pay? In order to get a basis for answering this, assume first that the duplication of machinery is complete, that is, that there is no available water power during a part of the year and that it is

therefore necessary to have a steam plant that can carry the entire load during such period. A brief consideration will show that practically the only saving that can be obtained by the operation of a water-power plant as an auxiliary to a steam plant is the saving of the fuel which would be burned if the water plant were not operated. The item of labor for attendance will certainly not be reduced. In fact, the attendant expense is apt to be increased, since during a considerable part of the year both plants would have to be operated, necessitating practically a double crew. Supplies, such as oil, waste, etc., would not be reduced by the operation of the double system, nor would maintenance and repairs be reduced as the upkeep on the steam plant is apt to be even higher if run intermittently than if run continuously.

Another feature which plays an important part is the load factor. The lower the load factor, the smaller will be the number of kilowatt-hours turned out per kilowatt capacity of machinery installed; also the smaller will be the fuel bill per kilowatt of machinery installed. Table 2 indicates, in the first column, the load factor, and in the second column, the total number of kilowatt-hours which a plant will put out for each kilowatt-hour of maximum load; the third column shows the cost of the fuel for each kilowatt of maximum load at 0.5 cent per kilowatt-hour, and the fourth column, the maximum amount of money per kilowatt that should be put into a water-power plant for the conditions assumed. The figures in this column are arrived at by considering that the annual fixed charges on the water-power plant must not exceed the annual fuel bill, if the steam plant produced all the power. The fixed charges on the water-power plant are taken at 13 per cent. per annum, which is obtained by assuming 5 per cent. for interest, 6 per cent. for depreciation and 2 per cent. for insurance and taxes.

TABLE 2

Load Factor in Per Cent.	Kilowatt-hour per Year for Each Kilowatt of Capacity	Yearly Cost of Fuel per Kilowatt of Capacity at 0.5 Cent per Kilowatt-hour	Limiting Cost per Kilowatt of Auxiliary Water-power Plant
20	1750	$ 8.75	$ 67
30	2630	13.10	100
40	3500	17.50	135
50	4380	21.90	169

In arriving at the cost of a water-power plant, one should take into consideration not only the hydraulic development and the cost of the machinery but also the cost of transmitting the power from the plant to the market. This last item is very often an important one, since it is usually necessary to make the hydro-electric development at a considerable distance from the market, therefore making the cost of transmission high.

The figures in Table 2 were based upon the assumption that the water-driven plant will save all the coal. Reference to the curves in the figure will show, however, that this is much more than can actually be saved unless the stream be developed for the minimum flow only. If more than the minimum flow is developed, all the coal that would have been used by the equivalent steam plant could not, of course, be saved. To correct for this, the figures in the fourth column of Table 2 would have to be increased, the amount of this increase running as high as 33 per cent. for the conditions indicated by the cross-hatching on the curve.

In conclusion, it would seem that where load factors are low, the question of developing a water-power plant in a region such as Ohio is one that demands a very close scrutiny. The cost per kilowatt of a water-power development is a variable quantity, but it seldom runs below $100 per kilowatt, and sometimes runs to four or more times this figure. The amount spent in a water-power plant can therefore easily exceed the economic limit.

The Coming Chicago Convention of American Institute of Electrical Engineers

The annual convention of the American Institute of Electrical Engineers will be held in Chicago on June 26 to 30, inclusive, in the new Hotel Sherman, the most recently completed of Chicago's group of modern hotels. While the list of papers to be presented at the convention is not complete, the following partial list of papers that will probably be presented shows the diversity of subjects to be considered: "Economical Design of Direct Current Magnets," by R. Wikander; "Catenary Span Calculations," by W. L. R. Robertson; "Currents in Inductors of Induction Motors," by H. Weichsel; "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires," by Major G. O. Squier; "Electrolysis in Reinforced Concrete," by C. E. Magnusson; "Induction Motor Design," by T. Hoock; "The High Efficiency Suspension Insulators," by A. O. Austin; "The Electric Strength of Air," by J. B. Whitehead; "Electrification Analyzed, and Its Application to Trunk Line Roads," by W. S. Murray; "Telegraph Transmission," by F. F. Fowle; "The Cost of Transformer Losses," by R. W. Atkinson and C. E. Stone; "The Costs of Railway Electrification," by B. F. Wood; "Induction Motor for Single-Phase Traction," by E. F. W. Alexanderson; "Magnetic Properties of Iron at 200,000 Cycles," by E. F. W. Alexanderson; "Electric Storage Batteries," by Bruce Ford; "The Characteristics of Isolated Plants," by P. R. Moses; "Elevator Control," by T. E. Barnum.

New Coal Region Being Developed

To those who are looking forward with so much apprehension to the time when the coal supply shall have been exhausted, the announcement that a large tract of land in Kentucky is about to be developed will prove welcome news.

The Consolidation Coal Company has recently purchased a tract of 100,000 acres of virgin coal land known as the Elkhorn district in Kentucky, and is building a railroad of its own from Shelby to the mine. The Louisville & Nashville railroad is also building a branch to this district, and when these two are completed there will be adequate facilities for working the mines to their limit; which, it is estimated, will occur in less than two years.

Extensive borings have been made throughout the entire region, and the coal has been found to run in almost continuous veins of about 9 feet in thickness. It is a high-grade bituminous coal with about 37 per cent. volatile and possesses excellent coking qualities, making the byproduct gas available for gas-engine purposes.

Bill for Ventilation of New York Factories

A bill has been introduced into the assembly of the New York legislature by Mr. Boylan to regulate the ventilation of factories and workrooms in the State of New York. This is a measure for which a committee of the American Society of Heating and Ventilating Engineers, D. D. Kimball, chairman, has been working on for over a year.

The bill provides that a workroom must be ventilated so that the air within does not contain more than nine parts of carbon dioxide in 10,000 volumes of the air in excess of the number of parts of carbon dioxide in 10,000 volumes of the outside air, or so that there is constantly supplied throughout the interior of the room at least 1200 cubic feet of air per hour per person and in addition 1000 cubic feet of air for each cubic foot of gas burned per hour, the air to be taken from an uncontaminated source. The temperature must never be less than 55 degrees and, except in boiler rooms, never more than 72 degrees wet-bulb temperature, unless the wet-bulb temperature outside exceeds 70 degrees, when the wet-bulb temperature inside must not exceed the wet-bulb temperature outside by more than 5 degrees.

The means for ventilation must be provided for by the owner unless a written agreement can be shown that the occupier is to furnish the means.

Illinois N. A. S. E. State Convention

The seventh annual convention of the Illinois State association of the National Association of Stationary Engineers was held at Ottawa, Ill., May 19 and 20. After opening with prayer by Rev. W. G. Irish, Mayor Bradford spoke briefly to the delegates and W. H. Miller, also of Ottawa, delivered a cordial address of welcome. Response was made by F. W. Raven, national secretary.

John W. Lane, in speaking of the National Association of Stationary Engineers, made the suggestion that the State educational committee make an effort to get into closer touch with the University of Illinois at Urbana, and possibly hold, during the coming fall and winter, a session at the university, devoted to the practical problems which the operating engineer is meeting in his everyday practice.

E. P. Gould, secretary of the Central States Exhibitors Association, read a paper at the opening exercises in which he outlined methods by which the exhibitors and engineers could coöperate to the benefit of all.

At the Friday afternoon session Prof. K. G. Smith, of the University of Wisconsin, gave a talk on "Smoke and Smoke Prevention," in which he explained the fundamental laws of combustion and illustrated, by means of a kerosene lamp, how such laws must be observed to get good results. The proportions of oxygen and nitrogen in the air were taken up with reference to their effect on the carbon, hydrogen and sulphur in the fuel, the chemical problem involved being treated in an unusually clear and simple manner.

In speaking of developments in the burning of coal under boilers, Professor Smith told of a new practice in Europe. where a chain-grate stoker is being used under a marine-type Babcock & Wilcox boiler, with a stationary hand-fired grate located at the back end of the boiler in such a manner that on heavy loads the unburned fuel from the stoker will fall onto the stationary grate and burn; meanwhile the auxiliary grate can be stoked by hand if it becomes necessary, to carry the load.

Another subject of interest touched on by the speaker, was the problem of burning low-grade fuel in pulverized form. In an improved form, as introduced in Europe, the process consists of blowing the fuel upward into the furnace from the center of the grate, under a brick arch. It is claimed that by this method better combustion has been obtained and that boiler and furnace efficiencies from 76 to 82 per cent. are being realized.

W. F. Mozier, principal of the Ottawa high school, addressed the convention at the Saturday afternoon meeting, his subject being "A Practical Education." The professor spoke from experience in educating the young in the practical things of life and offered many suggestions as to how they could be guided in making a proper choice of their life work. Following Professor Mozier, W. A. Converse, of the Dearborn Drug and Chemical Company, gave an interesting talk on "The Purification of Boiler Feed Water," illustrating the important points with actual demonstrations, using chemical apparatus specially set up for the occasion.

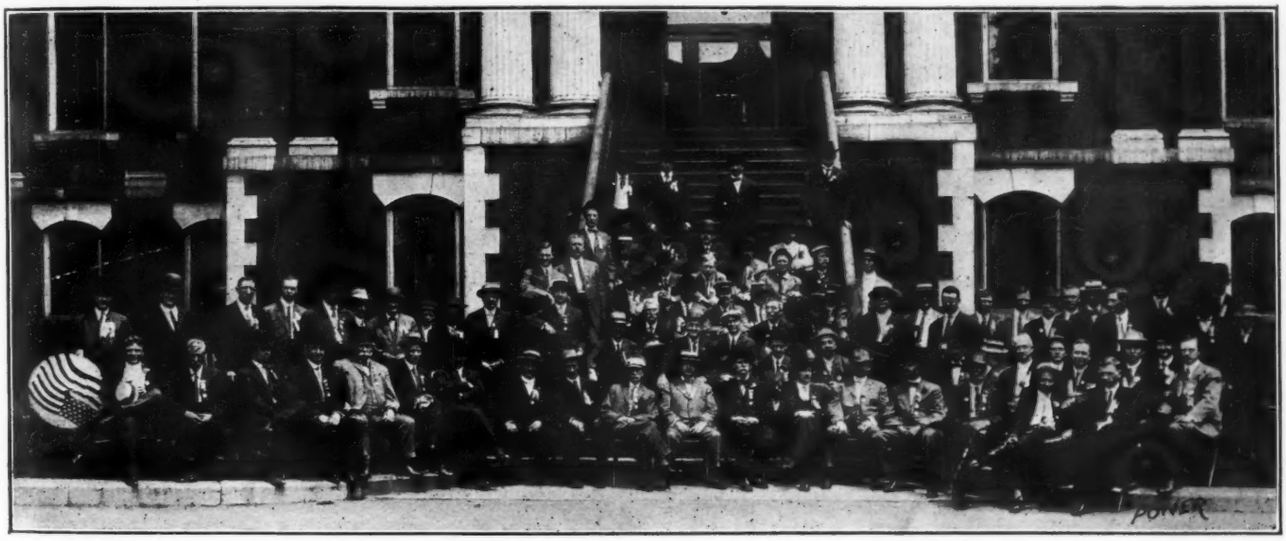
Ex-Mayor J. T. Farrell wound up the exercises with a spirited talk entitled "What I Know about Engineering," which was well received.

One of the pleasing events on the program was the presentation to No. 6, of Peoria, of a handsome blackboard, for the highest honors in the State educational contest, the winning grade being 94.3 per cent. The convention indorsed John F. McGrath, of Chicago, for national vice-president.

Officers for the following year were elected as follows:

John F. Alt, of Ottawa No. 10, president; John R. Moore, of Chicago No. 1, vice-president, and W. E. Hill, of Moline No. 17, reëlected secretary-treasurer. Place and date of the next convention were left subject to the call of the incoming officers.

The following firms exhibited: American Steam Pump Company, Battle Creek, Mich.; V. D. Anderson Company, Cleveland, O.; George B. Carpenter Company, Chicago, Ill.; Centralene Oil Company, Chicago Heights, Ill.; Crandall Packing Company, Palmyra, N. Y.; G. M. Davis Regulator Company, Chicago, Ill.; Dearborn Drug and Chemical Company, Chicago, Ill.; Garlock Packing Company, Palmyra, N. Y.; General Specialty Company, Buffalo, N. Y.; Greene, Tweed & Co., New York; Harrisburg Foundry and Machine Works, Harrisburg, Penn.; Hawkeye Boiler Compound Company, Chicago, Ill.; Hills McCanna Pump Company, Chicago, Ill.; Jenkins Brothers, New York; H. W. Johns-Manville Company, New York; Keystone Lubricating Company, Philadelphia, Penn.; George W. Lord Boiler Compound Company, Philadelphia, Penn.; Lunkenheimer Company, Cincinnati, O.; Lyons Boiler Works, De Pere, Wis.; McMaster-Carr Supply Company, Chicago, Ill.; *National Engineer*, Chicago, Ill.; Osborne High-Pressure Joint and Valve Company, Chicago, Ill.; Peerless Rubber Manufacturing Company, New York; POWER, New York; *Practical Engineer*, Chicago, Ill.; John Roebling Sons' Company, New York, and Sullivan Oil Company, Chicago, Ill.



VISITORS AND DELEGATES TO THE ILLINOIS STATE CONVENTION, N. A. S. E.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

Have you ever noticed that in the famous Greek statue of the Discus Thrower the athlete stands with his right foot forward, ready to hurl the discus?

For centuries the Greeks had thrown it this way—it was a custom, a tradition of their favorite national sport.

No one had ever stopped to think whether or not there was a better way of doing it.

But, in the 20th century—when discus throwing was more than 2000 years old—Martin Sheridan, the American athlete, went to Greece for the Olympian Games and entered the discus event for about the first time in his life.

He grasped the missile and threw it in the *natural* way, with his *left* foot forward, and in one throw smashed not only the ancient Greek custom but also the world's record.

In this little tale there are several morals.

The men who have accomplished things and gotten ahead of their fellows are nearly always the ones who have had the nerve and the brains to break with old traditions and customs.

In these modern times there have arisen newer, better methods of doing things—in the power plant as elsewhere.

And the man who puts his *best* foot forward, no matter what *custom* has decreed, is the man who will make new records and get farther ahead in his profession.

That most engineers realize this is proved by the fact that most engineers nowadays read the ads. in their technical paper.

They know that the *newer*, *better* ways to do the old things are *advertised*—and they follow those ads. conscientiously, and profit thereby.

The engineer who reads the Selling Section of POWER these days is the man who is putting his best foot forward in the double-quick march of Progress.

Are you one of them?

Annual Exhibition of Student Work at Pratt Institute

The annual exhibition of the work of the students of Pratt Institute will be held on June 1, 2 and 3. In the school of science and technology, which is the division of the institute especially concerned with the training of young men in industrial and technical lines, the various classes will be at work in the shops and laboratories during the exhibit and thus an excellent opportunity will be given those interested to inspect not only the results of the students' work, but also the methods of instruction and the general facilities for conducting this kind of training.

A special feature of the exhibition will be the opening of the new tannery of the institute, recently installed to provide for the courses in tanning and leather chemistry which are to be conducted in coöperation with the National Association of Tanners.

PERSONAL

On Saturday, May 20, Charles H. Simmons, president of the John Simmons Company, of New York City, sailed for Europe to spend a well earned vacation in a pleasure trip of several weeks.

William J. Schatz, formerly connected with the New York offices of several boiler-compound companies, is now working among the iron and steel plants of eastern Ohio as troubleman for the Texas Company.

H. M. Elder, recently in charge of the power plant of Abraham & Straus, Brooklyn, and Simpson-Crawford Company, in New York, has accepted a position as superintendent of power stations for the American Locomotive Company.

John J. Chisholm, formerly chief engineer of the Waterside station of the New York Edison Company, and lately chief engineer of the power house of the Westinghouse Electric and Manufacturing Company, has accepted a position as superintendent of power for the Tennessee Coal, Iron and Railroad Company, at Ainslee, Ala.

Charles F. Palmer has recently been placed in charge of the reorganized sales department of the J. Faessler Manufacturing Company, Moberly, Mo., makers of "Boss" and "Universal" flue expanders, flue cutters and other boiler tools. Mr. Palmer, who is well qualified for this position through previous experience in selling Faessler tools and as representative of the Frank E. Palmer Supply Company, of St. Louis, will have his office at 810 Oliver street, St. Louis, Mo.

SOCIETY NOTES

The sixth annual convention of the International Association for the Prevention of Smoke will be held at Newark, N. J., on June 28, 29 and 30.

The annual banquet of the Marine Engineers' Beneficial Association No. 33, of the Port of New York, was held on Tuesday evening, May 16, at the assembly rooms of the Lexington Opera House. Covers were laid for about two hundred, an appetizing dinner was served, and each guest was presented a pretty souvenir. William F. Yates, national president of the organization, acted as toastmaster, and introduced the following speakers: Jonathan A. Wilson, M. L. Malevinsky, Charles G. Armstrong, B. F. Ward, George Linn, H. L. Aldrich, William Duboise, James Waters and James Powers. The speeches were interspersed with a varied entertainment of song, story and recitation by the "Bunch."

BUSINESS ITEMS

James Merrick, formerly chief engineer of the Gas and Electric building, Denver, Colo., is now representing the Dearborn Drug and Chemical Works, in Salt Lake City, Utah, with headquarters at 144 South Fifth West street.

Owing to the rapid growth and increase of business of the R. G. Von Kokeritz Company, importer of engineers' specialties, it has added a large room to its office space in the Engineering building, 114 Liberty street, New York.

The Homestead Valve Manufacturing Company, Pittsburg, Penn., reports that it has appointed as its agents in Louisville, Ky., and vicinity, E. D. Morton & Co., who will carry a stock of Homestead valves and will be ready to supply the trade in that city and vicinity.

The Buffalo Forge Company, Buffalo, N. Y., report that its forge department is unusually busy with export orders for large installations of the Buffalo down-draft forges in foreign railroad and industrial plants. Among these are the Havana Railways, Havana, Cuba and the Central Railroad of Brazil.

The Boston & Maine Railroad Company is making a test with a high-pressure Vance steam trap to work under superheat. This trap is equipped with Monel metal valves and seat. The Vance steam trap is made by the George M. Newhall Engineering Company, 136 South Fourth street, Philadelphia, Penn.

The U. S. Steel Corporation has ordered a total of 900 Golden-Anderson cushioned triple-acting and nonreturn valves for the protection of its power stations. These valves and the other specialties, made by the Golden-Anderson Valve Specialty Company, Fulton building, Pittsburg, Penn., are illustrated and described in a new circular just issued, which will be sent to anyone on application.

The Phenix Lubricator Oil Pump, Square and Round Types," is the title of an attractive 16-page catalog recently issued by the Richardson-Phenix Company, of Milwaukee. Besides pointing out the special applications and advantages of the Phenix force-feed lubricator for cylinder lubrication on main units and auxiliaries, the proposition of adequately lubricating auxiliaries is discussed at some length. Interesting data concerning different types of power plants show that the rubbing surface and also the power consumption of auxiliaries bear a rather high ratio to the total power output of the plant. The pamphlet then points out that it is foolish to spend a lot of money in proper lubrication of main units without devoting some attention to the auxiliaries. Copies of this pamphlet may be had by addressing the Richardson-Phenix Company, Milwaukee, Wis.

For some months past the Geo. W. Lord Company, of Philadelphia, has been offering to give away to users of its boiler compound six Trill indicators complete, with reducing wheel, cord take up, 100 indicator cards, instruction book, etc., and the whole packed in a neat mahogany case. The first indicator was given to Curtis Warrington, who has been employed by Brewer Brothers, Philadelphia, continuously since 1875, and during all that time has used Lord's compound. Mr. Warrington is a member of the American Society of Mechanical Engineers and several other engineers' societies. The Lord Company did not agree to give out other prizes than the indicator, but in looking over the returns they found that S. P. Morris, Hermosa Beach, Cal., had been using the compounds continually since 1878 and G. C. Wilhelm, East Liverpool, Ohio, had been using it since 1879. This was too long a record to have without receiving some recognition, so the Lord company sent each of them a Waltham watch. The second indicator will be awarded this month.

The Burt Manufacturing Company, of Akron, Ohio, manufacturer of oil filters, has just received another order from the United States Steel Corporation for two filters of what they term their Gary unit type, as this particular type of filter was first installed in the plant of the United States Steel Corporation, at Gary, Ind., and after these last two filters are in operation this will make a total of 14 of these filters in use in this plant. The first order called for five units, and after six months' trial it duplicated the order. Later on it ordered two more, and with the two just ordered makes the total 14. These filters are used in connection with the flush system of lubrication, and each filter is cleaning 2000 gallons of oil per hour, or 28,000 gallons per hour for the 14, making this oiling system the largest installation in the United States. The outside shells of these filters are made of No. 10 gage iron, riveted and caiked, and the inside construction of No. 16 gage, making them strong and durable. All fittings are extra heavy, and are screwed into heavy brass flanges. The filters are so constructed that any number can be operated as one, and additional filters attached without changing any connections.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

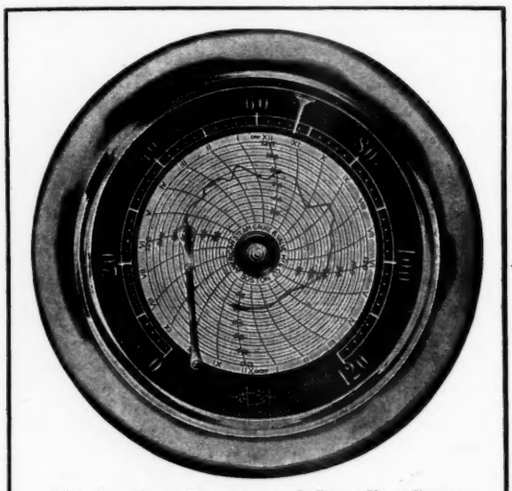
AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Competent high pressure boiler salesman; will give the right man an opportunity of investing in a business established for forty years. Address Box 444, POWER.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

The American Pressure and Recording Gauge



The American Pressure and Recording Gauge

Tells The Manager How Well You Are Doing Your Work

Shows the man at the top at a glance whether the fires are be-being taken care of as they should.

Shows him that you are looking after your job—that you are using the coal so as to secure greatest possible results.

It gives the manager a daily record of the pressures carried on the boilers and gives him an accurate record of exact pressure conditions every minute the boilers are in use.

Can be placed in the manager's office or in any other part of the plant.

It's as big a benefit to the fireman and engineer as to the manager. It encourages better work and furnishes the most convincing kind of proof that the firing is being done capably.

Write for details of this and our other steam specialties.

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

New York, 26 Cortlandt St. **Atlanta, 525 Candler Bldg.** **Chicago, 130-132 No. Jefferson St.**
Pittsburg, 8076 Jenkins Arcade Bldg. **San Francisco, Monadnock Bldg.** **Montreal, 444 St. James St.**

Make yourself eligible for a better job by making yourself BETTER in your present one—The

American-Thompson Indicator

(The only original J. W. Thompson Improved Indicator—all others are imitations)

will help you promote yourself

It will make you a better engineer—a more confident engineer. It will make you sure where now you have to guess. It will make you completely familiar with what's happening inside the cylinder.

It will enable you to prove that you are running your engine economically, that the valves are properly adjusted, that the piston isn't leaking, that the utmost value is being secured from the coal burned.

In other words, it will give you the ability you need to secure better pay. It will help you upward, whereas without an accurate indicator, an American-Thompson, to help, you cannot secure the engine-knowledge that is essential to the engineer who wishes to push himself ahead.

The American-Thompson, due to its quality construction, is the recognized standard indicator.

It is always accurate, after years of use as when new.

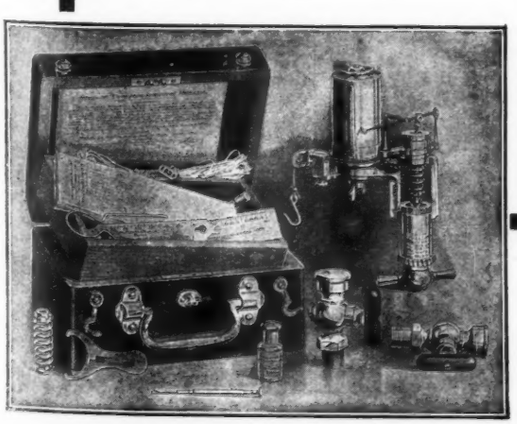
It is an indicator you can depend on year after year; it will not mislead you.

And you can ***afford*** to buy it—the price is right and the terms bring it within easy reach.

$5.00 Down—$5.00 Monthly

(Complete Price of Outfit Shown is $55.00)

Send the first payment, with reference, today. The indicator itself will help pay the balance. Many an engineer has secured a desired raise with its aid before many payments had been made. We give you the privilege of examining your outfit for five days. Don't put this important matter off any longer—if you want to help promote yourself—there's no better time to start in than ***right now.***



Mail The Coupon Today

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator offer No. 112

Name.....

Address.....

City and State.....

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

POSITION OPEN—Water wheel chief engineer; thoroughly competent designer and constructor to take full charge of latest up to date Francis turbine wheels and governors; applicant must have extended experience; give full particulars. Box 441, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

EXPERIENCED steam and gas engineer open for engagement; practical installation and economical operation of engines, producers, generators and refrigerating machinery. Box 446, POWER.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

GAS ENGINEER to take charge of producer gas engine plants, familiar with the erecting and operating of large horizontal and vertical gas engines; suction and pressure producers; low and high grade fuel; indicating and fuel analyses; mechanic and machinist; now in charge of 2000 horsepower plant in Mexico; age 37; willing to go to any place. Box 440, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

The Vulcan Soot Cleaner offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

YOUR SALES AGENCY WANTED—Experienced mechanical and electrical sales-engineer wants eastern Pennsylvania agency; boilers, engines, generators, pumps, blowers, heating, steam or electric specialties; intimate acquaintance with architects, engineers, contractors, etc.; 16 years in territory. Box 385, Care E. C. Rahme, 38 N. Broad St., Philadelphia, Pa.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—One Cooper Corliss engine, 14—24x42 cross compound; in good order; now running; can be seen any day. John Boyle Co., Jersey City, N. J.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—50 horsepower horizontal tube Bigelow boiler, 35 horsepower Greenfield vertical engine, both in good condition; will sell together or separately. General Acoustic Company, Jamaica, N. Y.

FOR SALE—Two used horizontal tubular boilers, 66 inches diameter by 16 feet long; 54 four-inch tubes; 90 pounds pressure allowed by insurance company; in good condition. Herman Behr & Co., Inc., 45 Tiffany Place, Brooklyn, N. Y.

FOR SALE—One compound Reynolds Corliss engine, high pressure cylinder 32 inches, low pressure 60 inches, stroke 60, 1200 horsepower at 100 pounds pressure, 70 revolutions per minute, flywheel diameter 20 feet, face 56 inches, built in sections; shaft length 16 feet diameter in wheel 16 inches, single eccentric. Box 434, POWER.

FOR SALE—One 90-h.p. return tubular boiler; one 90-h.p. Worthington water tube; McClave four section grate for both furnaces; two Payne engines, 11x12 and 10½x10, each connected to 40-kw. Eddy generators, one belt connected and one direct; one 1½-h.p. Eddy motor and starting box; one Dean pump, 14x8½x10; one Dean pump, 3x2x3; two Dean pumps, 4½x2¾x4; two hydraulic elevators, horizontal cylinders, gear 12 to 1 and 10 to 1; lift of elevator, 90 feet. This machinery in good condition. Enlarging of plant, cause of disposal; sell all, or in part. Lyons & Chabot Dep't Store, 150th St. and 3d Ave., Bronx. See chief engineer.

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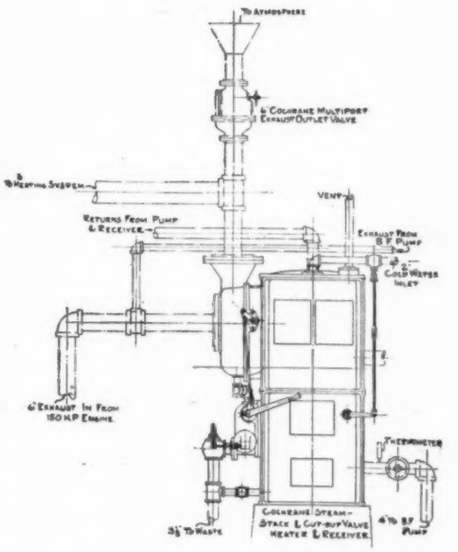
Saving A Ton Of Coal A Day In A 150 H. P. Plant

A gentleman who at our request recently visited a wall paper company's power plant, in which we some time ago installed a **COCHRANE STEAM-STACK AND CUT-OUT VALVE HEATER AND RECEIVER** in connection with an exhaust steam heating system writes us as follows:

> *"Mr. ———— states that he has saved over a ton of coal a day, heats the old building and the new building, measuring 300 ft. by 50 ft., and three stories high, saving him a new boiler, and the heater has paid for itself to date."*

If you can save a ton of coal a day by applying the exhaust steam from a 150 H. P. engine to heating the plant, how much could you save in your plant? Figure it out.



A ton of coal a day, you see, is something like **500** Dollars a year, or more if you are using hard coal. Isn't that worth going after?

The **COCHRANE STEAM-STACK AND CUT-OUT VALVE HEATER AND RECEIVER** not only reheats the condensed returns, and supplements them with raw cold water to make up the boiler feed, but it also purifies of oil all the exhaust steam delivered by the engine, as shown in the accompanying diagram, so that it can safely be passed to the heating and drying coils, and will not foul the latter with grease, and the condensed returns can be brought back and used for boiler feeding, since the steam has been entirely purified of oil by its passage through the extra large separator attached to and forming a part of the heater.

If it is necessary to operate the heating system 24 hours per day, that need not interfere with occasionally cleaning the heater, since valves are incorporated between the separator and the heater, and between the trap which drains the separator and the heater, so that the latter can be cut out of service for cleaning or inspection while the trap and separator remain in service. These valves are connected together by a **FOOL-PROOF** valve gear, so that you cannot turn one valve without turning the other; moreover, while you are opening the heater you can take the handle off, so that no one can turn steam in on you.

If you are interested in the utilization of exhaust steam for heating or drying purposes, you should read our "*Exhaust Steam Heating Encyclopedia*," which describes all the commercial exhaust steam heating systems. We shall be pleased to send you a copy of this book if *you* will kindly give

(1) Your address and the name of the firm with which you are connected, also
(2) The horse-power capacity of the plant and
(3) The present temperature and method of heating your boiler feed water.

HARRISON SAFETY BOILER WORKS

17th and Clearfield Streets **Philadelphia, Pa.**

After May 1, 1911, our New England Office will be located at 1045 Oliver Bldg., Boston, Mass.

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Jenkins Bros. Pump Valves are made from various compounds suitable for cold, warm or hot water, either high or low pressure; for naphtha, mild acids, ammonia or very muddy and gritty water and in brief, for every pumping requirement.

But no matter for what purpose a Jenkins Bros. Pump Valve is made, it is made in the best possible way.

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In ordering be sure to state the kind of service in which valves are to be used, the fluid handled, pressure or head pump is working against and give diameter, thickness and size of hole.

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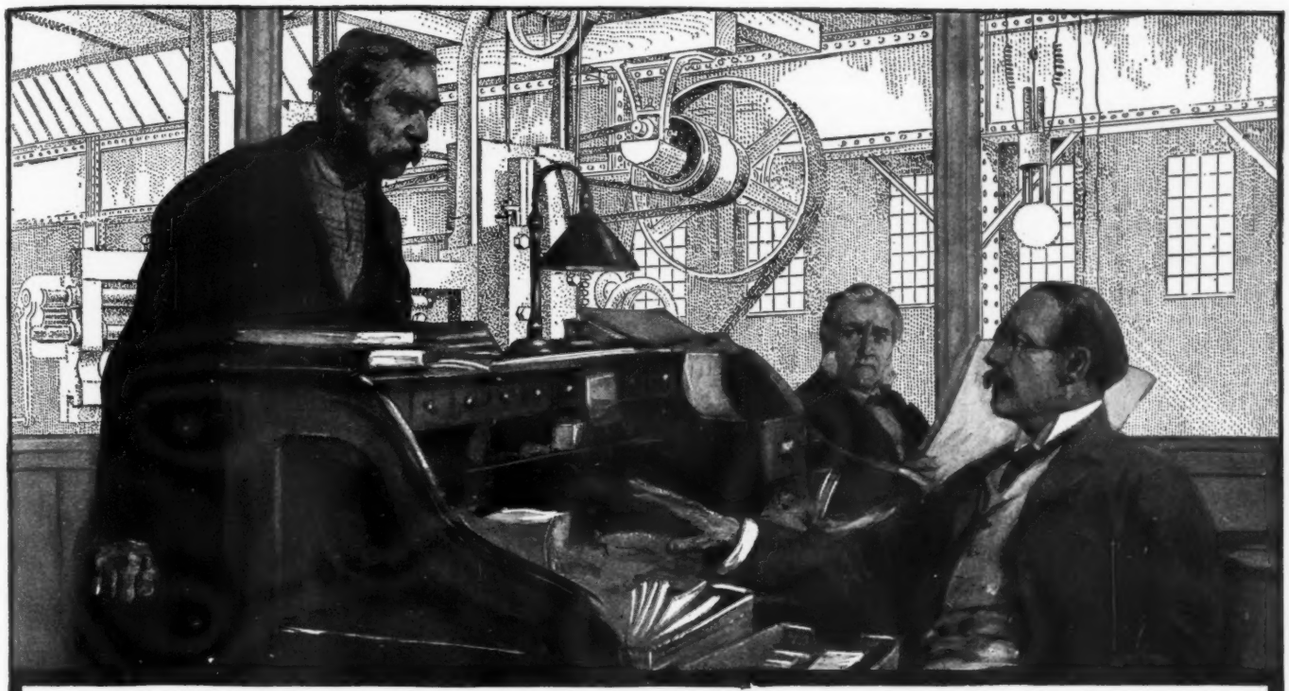

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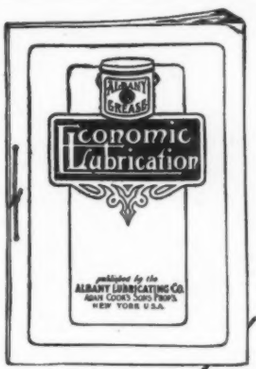

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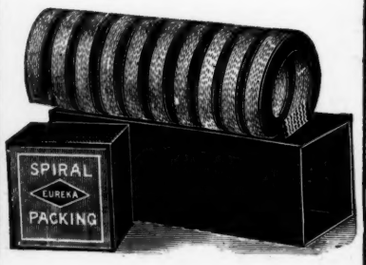

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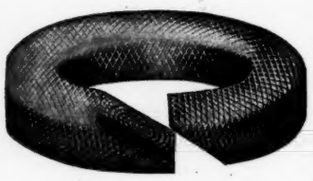

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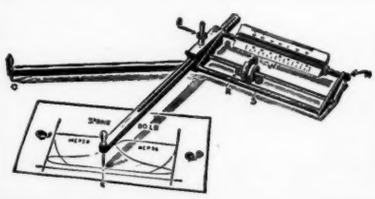

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